MEETING TORONTO'S ELECTRICAL NEEDS - AN INCREMENTAL APPROACH

REPORT OF THE JOINT ELECTRICAL
ENERGY PLANNING STUDY

OCTOBER 1984

The Joint Electrical Energy Planning Committee
was established in May 1982
by Toronto City Council,
the Toronto Hydro Electric Commissioners,
and Ontario Hydro.

The Committee consists of staff from:

Toronto Hydro
Ontario Hydro
City of Toronto Planning & Development Department
City of Toronto Public Works Department

JEEP FINAL REPORT

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EXECUTIVE SUMMARY

The Joint Electrical Energy Planning Study has been a two-year review of electrical needs in the City of Toronto, carried out jointly by staff of Toronto Hydro, Ontario Hydro, and the City.

The Study forecasts a significant increase in the City's peak electrical loads over the rest of this century, from approximately 1500 MVA to approximately 2500 MVA. The JEEP Committee believes, however, that it will be possible to provide sufficient capacity to handle these loads at existing transformer station sites, and without significant adverse impact on adjacent neighbourhoods.

The JEEP Committee stresses that its forecast is clouded with uncertainty around such factors as the impact of electric heating demand, future public interests in energy conservation, future programs to promote electricity use, the rate of real estate development in the City, and the timing of development in the Railway Lands and Waterfront. In view of this uncertainty, it recommends an ongoing joint forecasting and planning process.

It is possible that a new transformer station may be required in this century in the area south-west of downtown Toronto. The JEEP Committee has therefore identified, as an option to be protected, a site in the Railway Lands.

The JEEP Committee has briefly reviewed a number of measures for reducing electricity demand and hence deferring new facility needs. It believes that none will have a very large impact, but that load management, time-of-use rate structures, grants and loans, and programs to promote energy conservation are all strategies worth pursuing.

. . . /2

1.0 THE J.E.E.P. STUDY'S BACKGROUND, PURPOSE AND SCOPE

1.1 Background: Electricity Demand Boosted by Downtown Development Boom

For the past fifteen years, development activity in Toronto's downtown Core Area has been intense. The amount of office space has more than doubled since 1969. And in the eight years since the Central Area Plan was adopted, nearly 10,000 new dwelling units, many of them condominium apartments, have been built in and around the Core.

This activity forced Toronto Hydro to re-assess its ability to supply reliable electrical service to all of its downtown customers. New transformer and switching facilities seemed an urgent need, especially since the trends indicated a continuing rapid growth in electricity use per square metre of building area.

Anticipating this need, Ontario Hydro in the late 1960's had bought up the block bounded by Beverley, Baldwin, Cecil and Henry Streets, northwest of the Core Area, proposing to build a major terminal station. The proposal generated strong resistance from neighbourhood residents, supported by City politicians. Ontario Hydro decided to postpone construction on this 'Hydro Block' site, and later sold it to the City for housing development.

In January 1973, Ontario Hydro came forward with a new proposal to build a (physically) smaller terminal station at the corner of Orde and McCaul Streets. Once again there was opposition from the community and City Council. The discussions dragged on throughout the mid 1970's, as the energy crisis popularized conservation and electricity consumption growth rates slowed noticeably. In October 1979, Ontario Hydro announced it was deferring indefinitely the Orde/McCaul proposal.

. . . /3

Instead, to secure at least some increase in its capacity to serve the downtown area, Ontario Hydro proposed adding extra 115kV circuit breakers to its existing station at Cecil and Huron. Contained entirely within an expanded building on the site, this new proposal would have a minimal impact on its neighbours. In March 1981, City Council decided to proceed with the necessary rezoning for the site. Final approval was given by the Ontario Municipal Board in late 1983, and construction is expected to be complete in 1987.

City Council did more than simply approve the Cecil expansion. Having heard the utilities' case, it requested Toronto Hydro and Ontario Hydro to work with City staff in identifying sites for future facilities to serve those parts of the City where electrical demand was on the increase. The utilities responded by proposing a joint study of long run demand projections. After further discussion, terms of reference were agreed to by all parties, and in May 1982 the Joint Electrical Energy Planning Study, known as the JEEP Study for short, was set in motion.

1.2 Purpose: From Demand Forecasts to Facility Needs

The JEEP Study's terms of reference called for a comprehensive study to determine electricity demand for the City in the medium term (5-10 years) and in the long term (10-20 years). The Committee was also asked to recommend the most appropriate means of augmenting the existing bulk level system capacity, that is, the lines, switches and transformers that supply power at a voltage of 115 kV or more, in order to meet the projected demand. Finally, it was to "develop a framework for continued collaboration" on the question of electricity planning for the City of Toronto. The full terms of reference appear as Appendix A.

1.3 Scope: Broader and Narrower than Intended

The JEEP Committee's work has focused on monitoring electrical demand and examining supply strategies, as called for in its terms of reference. But its scope has been broadened in one sense and narrowed in another.

. . ./4

The original idea of a comprehensive computer-based forecasting methodology proved impractical, for reasons set out in Chapter 3, and the Committee settled instead for enhancing the forecast techniques already in use by Toronto Hydro. This change also reduced the forecast's time horizon, and contributed to a different kind of facility need analysis. Rather than using an agreed-upon long range forecast to derive a master plan for new stations and transmission lines, the Committee has gone to an incremental approach. This involves annual reviews of changing conditions and forecasts, and dealing with capacity problems on a facility basis.

This report sets out a number of possible medium-term facility changes, and proposes an ongoing process for monitoring growth in electrical loads and revising projections.

This narrowing in the scope of projections and long range plans has been offset by a broadening in other directions. Toronto Hydro has used the Committee as a forum in which to discuss various proposed changes to its transformer stations and to explain its new program for replacing overhead wires in residential areas. City planners worked through JEEP to bring about a review (with Harbourfront Corporation) of the future of Ontario Hydro's property at 230 Queens Quay West. And City staff were able to work collaboratively with Toronto Hydro on improving the design of the latter's annual electric heating consumer survey.

1.4 Procedures: Open Meetings and Consultation

The JEEP Committee held two dozen meetings during the two and a half years of its existence. All of these were open to the public, and a number of interested individuals were regularly notified of time and place, and received minutes on request.

An Energy Probe representative attended almost all meetings, contributing to the Committee's discussions and work in a way that was both provocative and valuable.

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Outside experts were periodically invited to attend meetings of the JEEP Committee or its Load Forecast Task Group, and their input contributed materially to the work. In addition, the Committee sponsored a special morning-long seminar on the prospects for electrical load change in downtown office buildings. The invited speakers were consulting engineers with practical day-to-day experience working with office building owners and developers. They significantly furthered the Committee's understanding of this key demand sector. (A record of the seminar forms Appendix B).

The JEEP Committee issued a brief interim report in August, 1983. A copy appears as Appendix C.

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2.0 THE SUPPLY & DISTRIBUTION SYSTEMS: HOW TORONTO GETS ITS ELECTRIC POWER

This chapter describes the three basic elements which bring electric power to Toronto's homes and businesses: the supply system used by Ontario Hydro to get electricity into the City, the fifteen transformer stations that reduce its voltage to 13.8 kV, and Toronto Hydro's low voltage distribution system. The chapter concludes with a brief description of the ongoing planning process used by the two utilities. Technical terms used in this chapter and elsewhere in the report are explained in the Glossary.

2.1 Ontario Hydro's 115 kV Supply System

Toronto's electric power is supplied from Ontario Hydro's bulk power system through 230-115 kV transformer stations located in Etobicoke (Manby Transformer Station, on Kipling Ave. north of the Queensway) and East York (Leaside Transformer Station, adjacent to the old C.P. Railways passenger station). From these stations a 115 kV transmission network, much of which is underground, carries electricity to fifteen transformer stations throughout the City of Toronto. The voltage at these stations is reduced to 13.8 kV for distribution to Toronto Hydro's customers through a low voltage system.

The Ontario Hydro 115 kV supply system is designed and operated such that customer service will not be interrupted and no system element will be subjected to damaging overloads if any one system element is taken out of service, whether because of faulty equipment or for routine maintenance. The design, known as the Dual Element Spot Network (or DESN) system, basically involves providing two of each component - transformers, circuits, etc. - operating in parallel, and ensuring that any one component can carry the entire peak load if the other fails. This means that most of the time the equipment operates at less than 50% of its maximum (short period emergency) capacity, but that when failures occur, there is no interruption of supply. The design and operation of the system are described in more detail in Appendix D.

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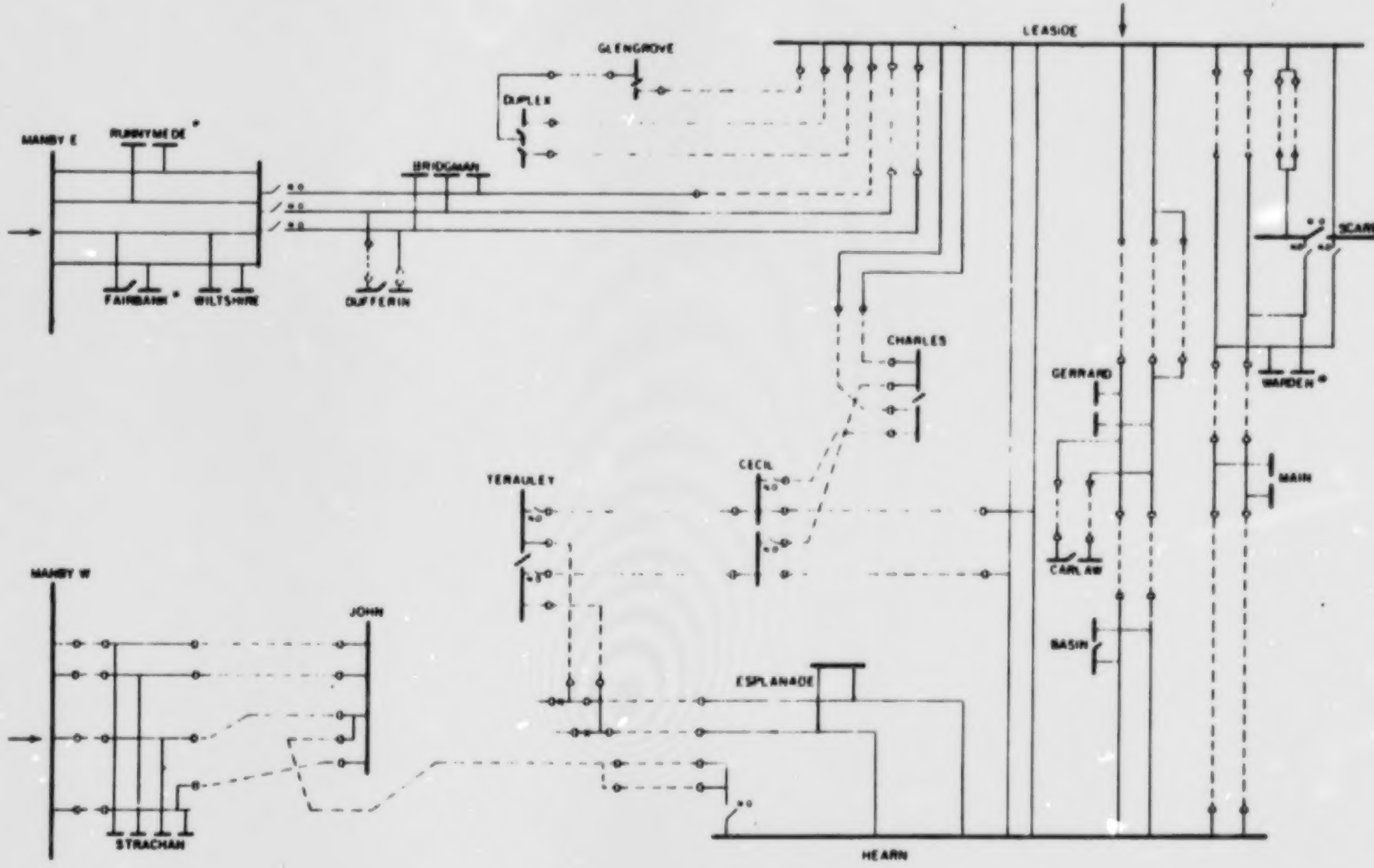
MANBY E
RUNNYMEDE *
FAIRBANK *
WILTSHIRE
DUFFERIN
BRIDGMAN
DUPLEX
GLENGROVE
LEASIDE
CHARLES
CECIL
TERAULEY
GERRARD
CARLAW
BASIN
MAIN
WARDEN *
SCARBORO *
ESPLANADE
HEARN
MANBY W
JOHN
STRACHAN
N.O.

LEGEND

——	Overhead Transmission Circuits
▷- - -◁	Underground Transmission Cables
—‖—	Cable out of service
→	Incoming power supply
*	Sta.ion located outside city
N.O.	Normally Open Point - power does not normally flow through this switch

Note: Generators at Hearn GS have been taken out of service and mothballed.

FIGURE 1
JOINT ELECTRICAL ENERGY PLANNING STUDY

TORONTO'S 115KV ELECTRICITY SUPPLY SYSTEM (SCHEMATIC)

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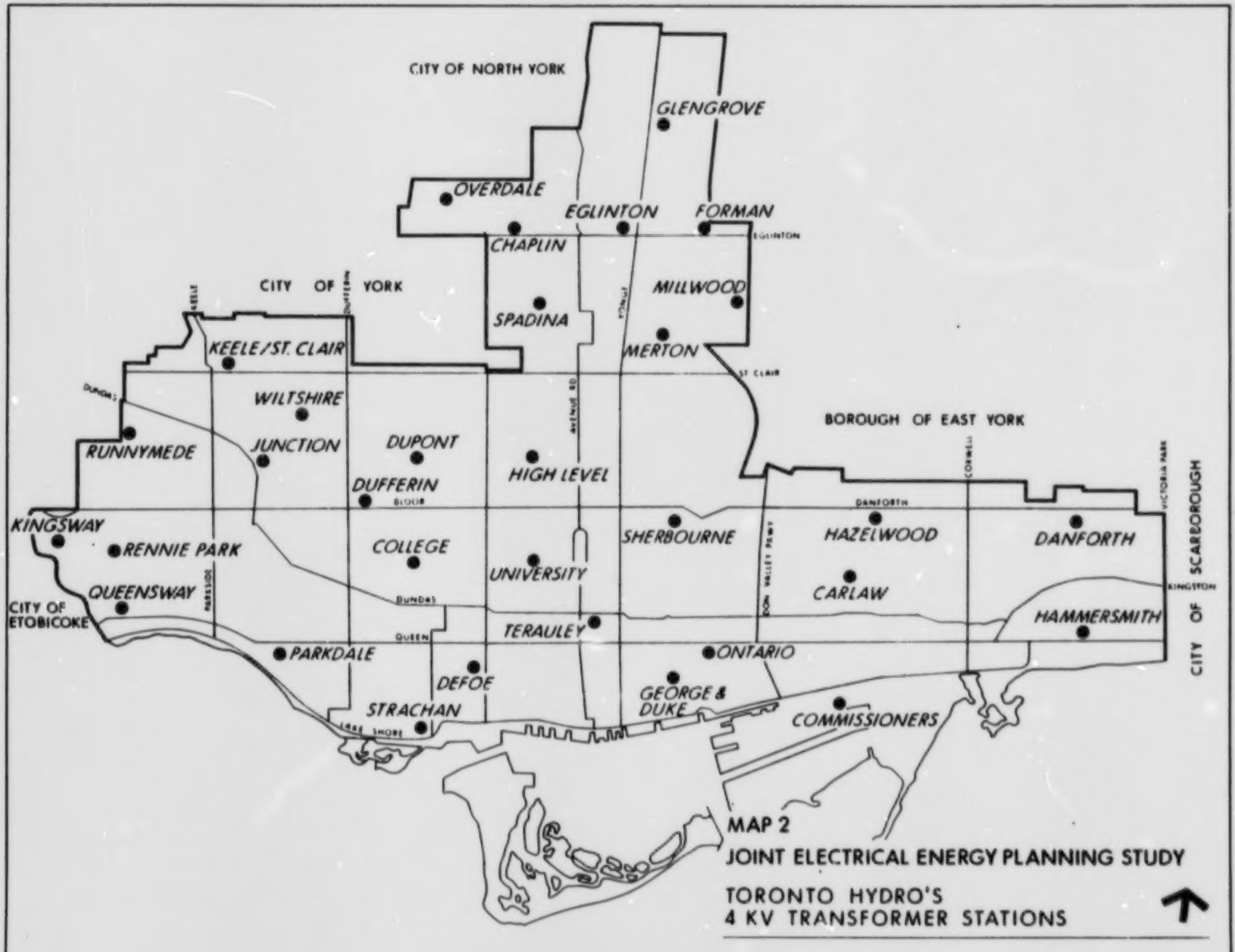
CITY OF NORTH YORK
GLENGROVE
OVERDALE
EGLINTON
FORMAN
EGLINTON
CHAPLIN
CITY OF YORK
KEELE
DUFFERIN
MILLWOOD
SPADINA
YONGE
MERTON
KEELE/ST. CLAIR
ST CLAIR
DUNDAS
WILTSHIRE
BOROUGH OF EAST YORK
AVENUE RD
RUNNYMEDE
JUNCTION
DUPONT
HIGH LEVEL
COXWELL
VICTORIA PARK
DUFFERIN
BLOOR
DANFORTH
KINGSWAY
RENNIE PARK
COLLEGE
SHERBOURNE
HAZELWOOD
DANFORTH
UNIVERSITY
CARLAW
KINGSTON
QUEENSWAY
PARKSIDE
DUNDAS
DON VALLEY PKWY
CITY OF ETOBICOKE
TERAULEY
HAMMERSMITH
CITY OF SCARBOROUGH
QUEEN
PARKDALE
ONTARIO
DEFOE
GEORGE & DUKE
STRACHAN
LAKE SHORE
COMMISSIONERS

MAP 2
JOINT ELECTRICAL ENERGY PLANNING STUDY

TORONTO HYDRO'S
4 KV TRANSFORMER STATIONS

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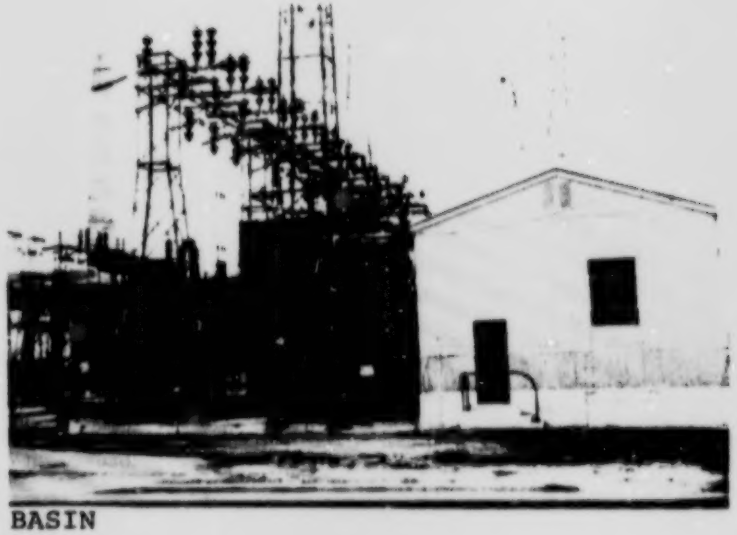
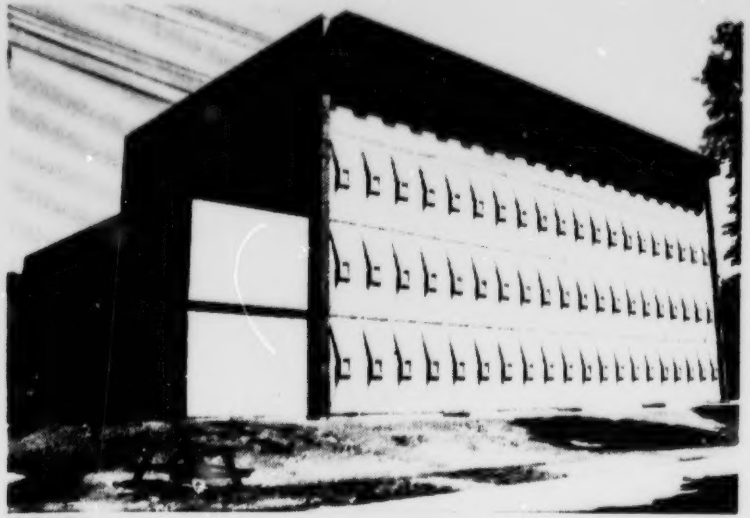


BASIN

BRIDGMAN



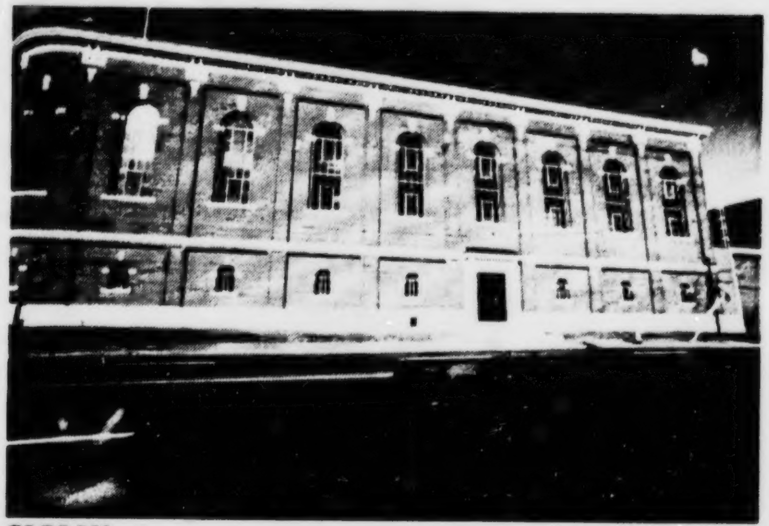
CECIL

CHARLES

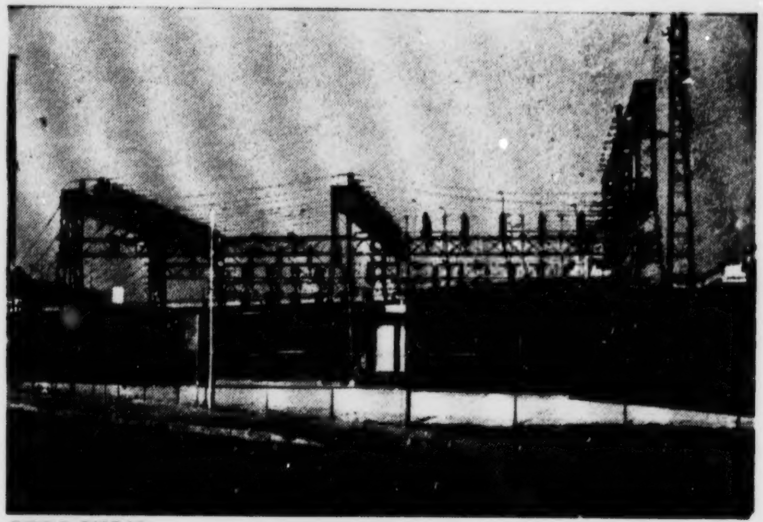
JOINT ELECTRICAL ENERGY PLANNING STUDY

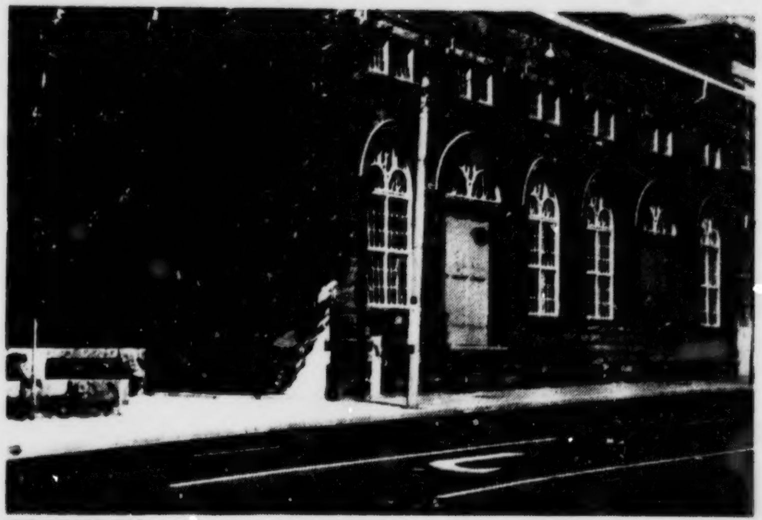
SOME 13.8 KV TRANSFORMER STATIONS ↑
IN THE CITY OF TORONTO

OCT. 1984


CARLAW

GLENGROVE


STRACHAN


TERAULEY

JOINT ELECTRICAL ENERGY PLANNING STUDY

13.8 KV AND 4 KV TRANSFORMER
STATIONS ON THE SAME PREMISES

OCT. 1984

Figure 1 shows schematically how Ontario Hydro supplies power to Toronto's 13.8 kV stations. In general, Strachan and John Stations are supplied from Manby West, Wiltshire is supplied from Manby East, and the remaining City stations are supplied from Leaside. The now-mothballed Hearn Generating Station, on Unwin Avenue in the City's port industrial district, functions as a switching station in the supply of power to a number of the 13.8 kV stations, as shown in Figure 1. Although the Runnymede and Fairbank stations are outside the City they have been shown on the diagram since they are fed from the lines which serve Toronto's Wiltshire Station and can, under certain circumstances, affect its power supply. Warden and Scarborough stations, similarly, are shown because they are supplied from Leaside.

2.2 The 13.8 kV Transformer Stations

The City of Toronto's electric supply and distribution system is built around the fifteen transformer stations shown on Map 1. These form the interface between Ontario Hydro's supply system and Toronto Hydro's distribution network. (Swansea and Forest Hill are exceptions; their power is supplied at 27.6 kV, and comes directly from Manby and Fairbank Stations, respectively.)

The equipment at eight of the 13.8 kV stations is wholly or mainly within a building. At the remaining seven, it is exposed. The photographs show what some of the 13.8 kV stations look like.

Each 13.8 kV station contains two, four, or six transformers for converting power from the 115 kilovolts at which Ontario Hydro supplies it to the 13.8 kilovolts at which Toronto Hydro distributes it. There is generally an even number of transformers, since they operate in pairs as part of the DESN system.

From the transformers, power flows to a bus (defined as a conductor or assembly of conductors for collecting electric currents and distributing them to outgoing feeders). Each bus has associated switchgear which incorporates a number of circuit-breakers.

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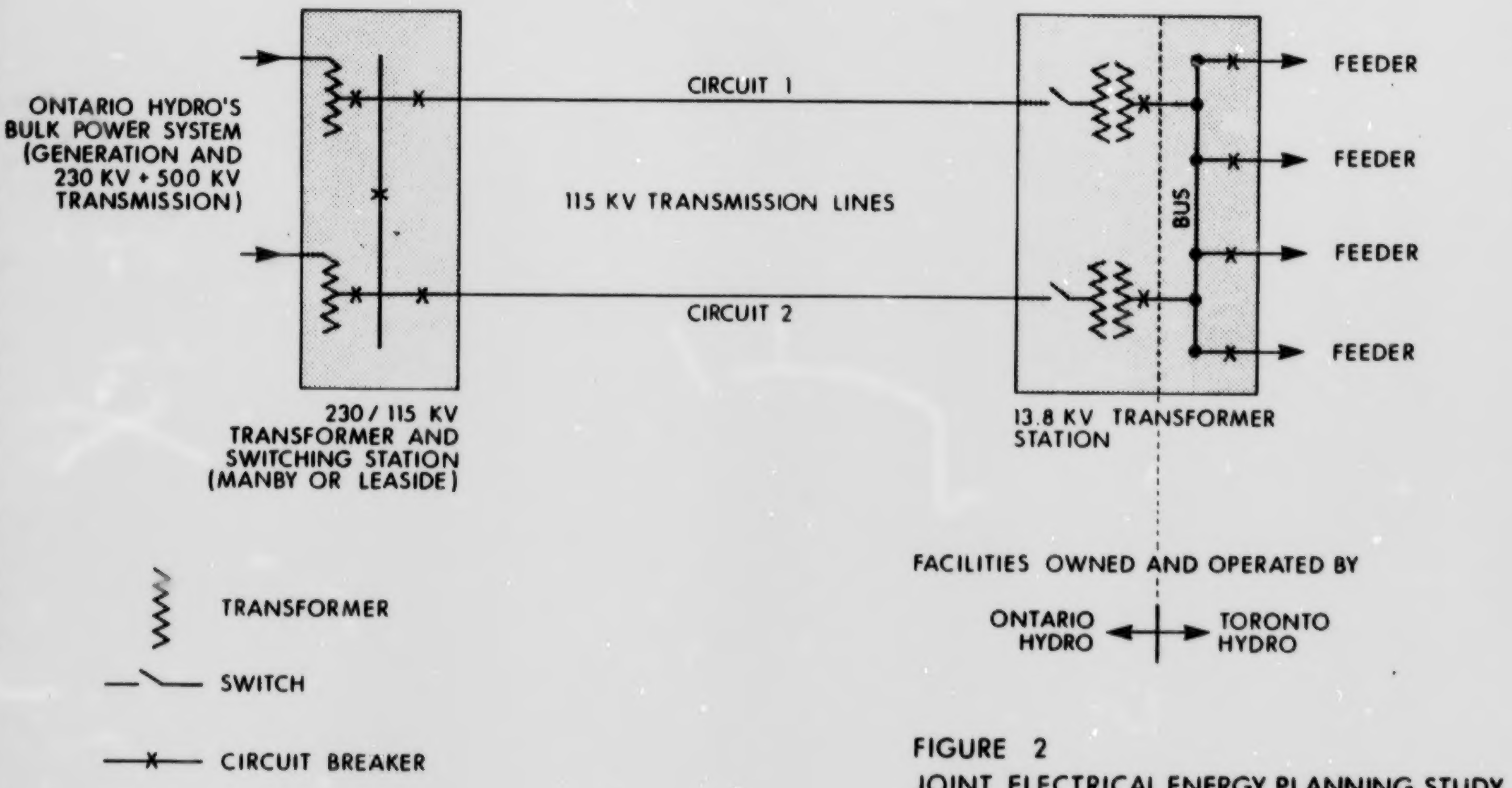
ONTARIO HYDRO'S BULK POWER SYSTEM (GENERATION AND 230 KV + 500 KV TRANSMISSION)
CIRCUIT 1
115 KV TRANSMISSION LINES
CIRCUIT 2
BUS
FEEDER
FEEDER
FEEDER
FEEDER
230 / 115 KV TRANSFORMER AND SWITCHING STATION (MANBY OR LEASIDE)
13.8 KV TRANSFORMER STATION
FACILITIES OWNED AND OPERATED BY
ONTARIO HYDRO
TORONTO HYDRO
TRANSFORMER
SWITCH
CIRCUIT BREAKER

FIGURE 2
JOINT ELECTRICAL ENERGY PLANNING STUDY

SUPPLY OF POWER TO
A TYPICAL 13.8 KV STATION

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Each circuit breaker, in turn, has at most two outgoing feeder lines connected to it. Typically, a bus serves between eight and fifteen feeders. Since each station has between one and six buses in total, it can be seen that the number of outgoing feeder lines varies from about eight in a small station such as Gerrard or Glengrove to about fifty in a large station such as Bridgman or John.

Figure 2 shows the operation of a 13.8 kV station with two transformers and a single bus. As explained further in Chapter 3, the bus is the basic unit for which load forecasts are prepared.

Most of Toronto Hydro's feeders are underground cables, and they are inter-connected to allow for load transfers in emergency or routine maintenance situations. This design ensures that service interruptions will be brief, and that no element of the system will be subjected to damaging overloads when one feeder is out of operation.

Expansion of the 13.8 kV feeder system is often difficult and costly due to space limitations. Existing duct banks may be filled or manholes too small. Space may not exist in the street for an additional duct bank. This is particularly a problem around stations where the egress is congested, such as Terauley. Spare feeder positions may not exist and space constraints may preclude the extension or addition of switchgear.

Since the 13.8 kV stations are part of the supply system as well as part of the distribution system, both Ontario Hydro and Toronto Hydro have a hand in their ownership and operation. The land and buildings are owned in some cases by the first, in others by the second. All transformers are owned and maintained by Ontario Hydro, while the buses are generally Toronto Hydro's responsibility.

2.3 Toronto Hydro's Local Distribution System

Public concern about hydro facilities has generally focussed around the supply system - transformer stations at 13.8 kV or higher levels, and high-voltage power lines. It was the need for these, and planning around that need, which formed the basic agenda for JEEP.

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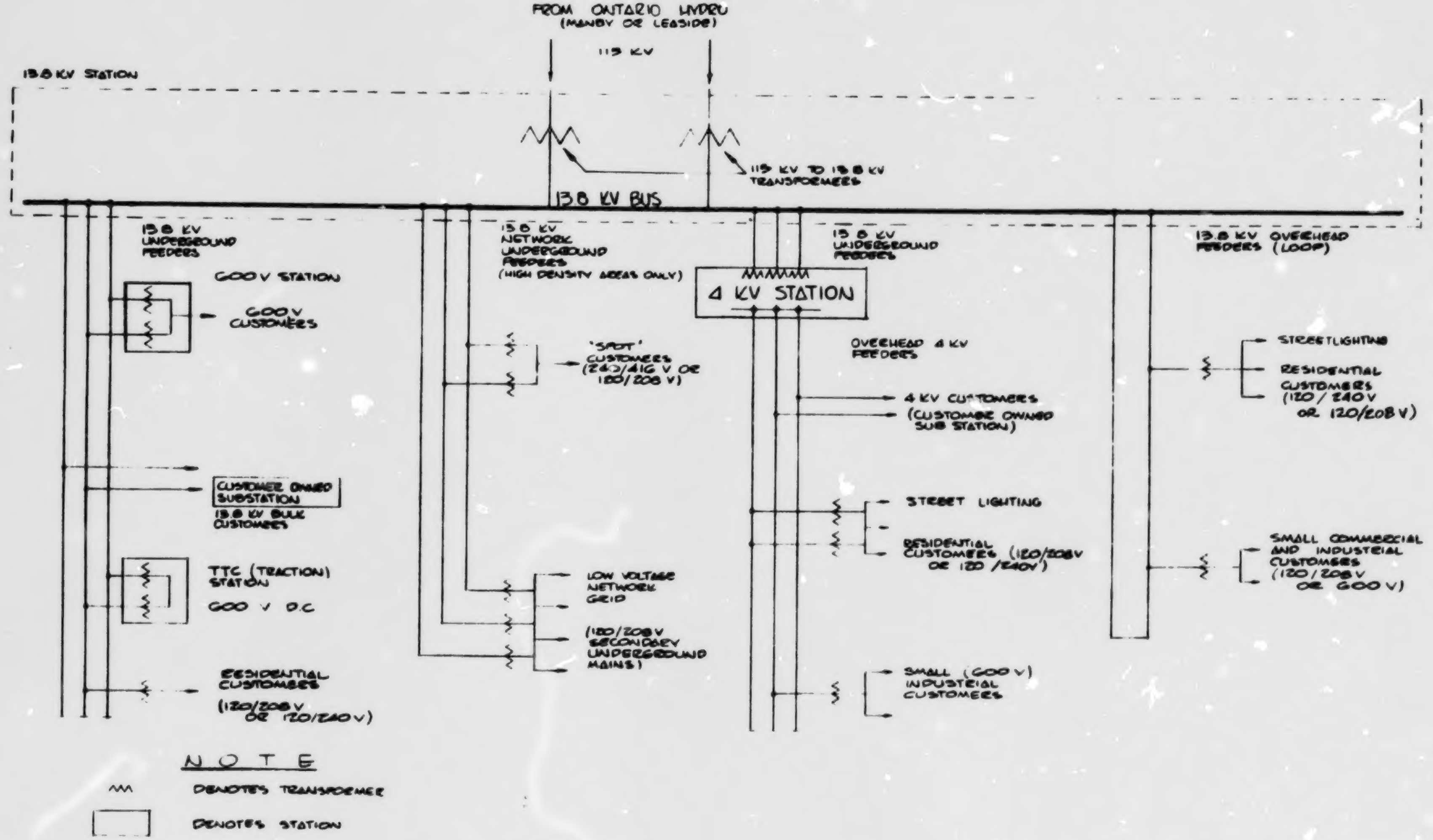
FROM ONTARIO HYDRO
(MANBY OR LEASIDE)
115 KV
13.8 KV STATION
115 KV TO 13.8 KV TRANSFORMERS
13.8 KV BUS
13.8 KV UNDERGROUND FEEDERS
600 V STATION
600 V CUSTOMERS
CUSTOMER OWNED SUBSTATION
13.8 KV BULK CUSTOMERS
TTC (TRACTION) STATION
600 V D.C
RESIDENTIAL CUSTOMERS (120/208 V OR 120/240 V)
13.8 KV NETWORK UNDERGROUND FEEDERS (HIGH DENSITY AREAS ONLY)
'SPOT' CUSTOMERS (240/416 V OR 120/208 V)
LOW VOLTAGE NETWORK GRID
(120/208 V SECONDARY UNDERGROUND MAINS)
13.8 KV UNDERGROUND FEEDERS
4 KV STATION
OVERHEAD 4 KV FEEDERS
4 KV CUSTOMERS (CUSTOMER OWNED SUB STATION)
STREET LIGHTING
RESIDENTIAL CUSTOMERS (120/208 V OR 120/240 V)
SMALL (600 V) INDUSTRIAL CUSTOMERS
13.8 KV OVERHEAD FEEDERS (LOOP)
STREETLIGHTING
RESIDENTIAL CUSTOMERS (120/240 V OR 120/208 V)
SMALL COMMERCIAL AND INDUSTRIAL CUSTOMERS (120/208 V OR 600 V)
NOTE
DENOTES TRANSFORMER
DENOTES STATION

FIGURE 3
JOINT ELECTRICAL ENERGY PLANNING STUDY

DISTRIBUTION OF POWER FROM A 13.8 KV STATION
(SIMPLIFIED SCHEMATIC)

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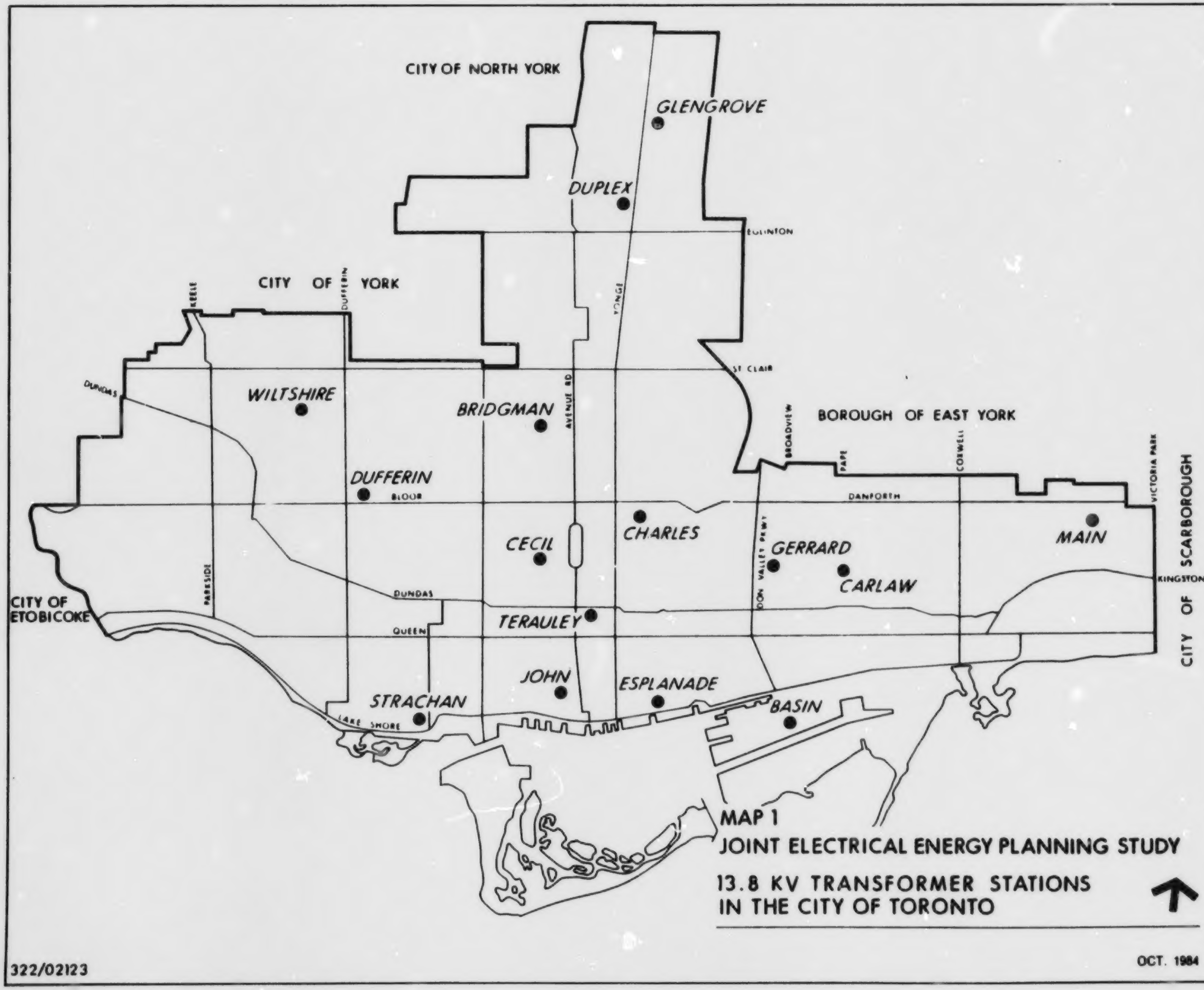
CITY OF NORTH YORK
GLENGROVE
DUPLEX
EGLINTON
CITY OF YORK
KEELE
DUFFERIN
YONGE
ST CLAIR
DUNDAS
WILTSHIRE
BRIDGMAN
AVENUE RD
BOROUGH OF EAST YORK
BROADVIEW
PAPE
COXWELL
VICTORIA PARK
DUFFERIN
BLOOR
DANFORTH
CECIL
CHARLES
GERRARD
CARLAW
MAIN
CITY OF SCARBOROUGH
KINGSTON
PARKSIDE
DON VALLEY PKWY
DUNDAS
CITY OF ETOBICOKE
QUEEN
TERAULEY
JOHN
ESPLANADE
STRACHAN
LAKE SHORE
BASIN

MAP 1
JOINT ELECTRICAL ENERGY PLANNING STUDY

13.8 KV TRANSFORMER STATIONS
IN THE CITY OF TORONTO

OCT. 1984

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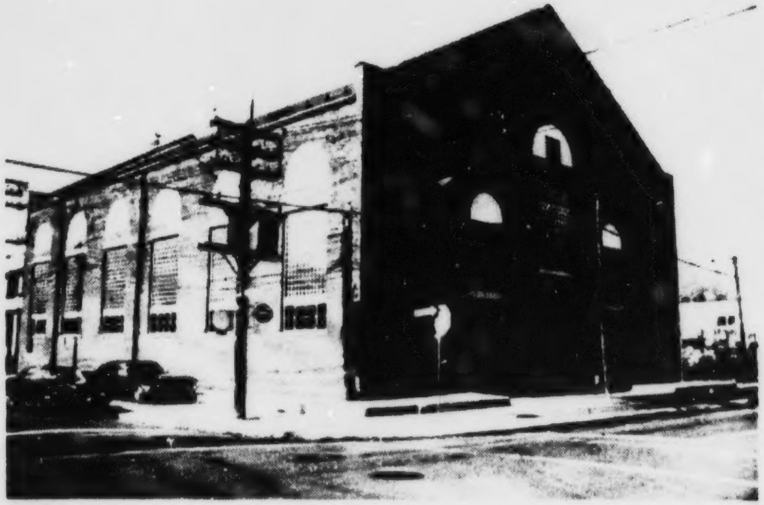
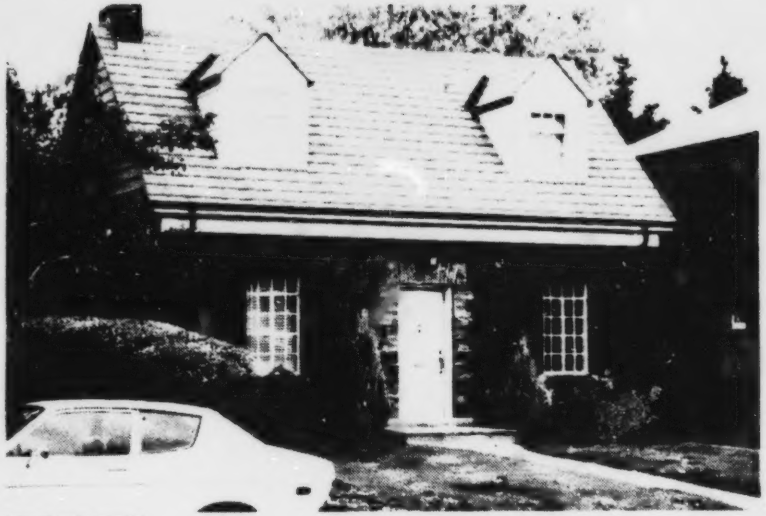
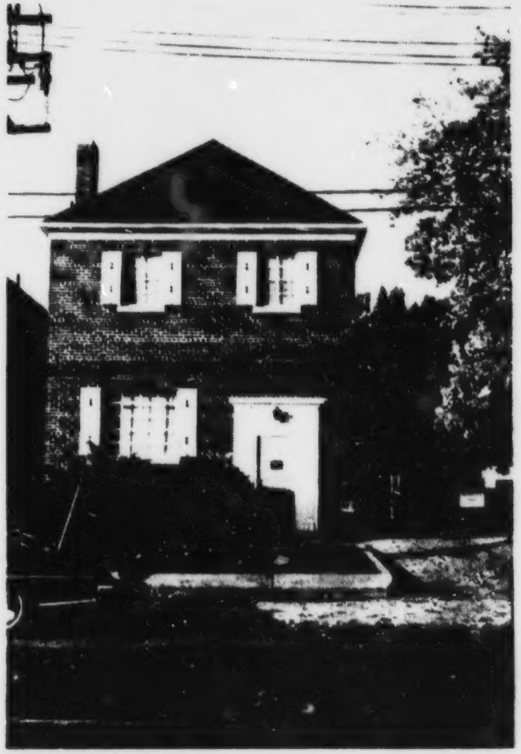


DEFOE



MILLWOOD



RUNNYMEDE

JOINT ELECTRICAL ENERGY PLANNING STUDY

SOME 4 KV TRANSFORMER STATIONS
IN THE CITY OF TORONTO

OCT. 1984

For readers of this report, however, the JEEP Committee decided to describe Toronto Hydro's distribution network. Although not a central focus of JEEP's work, the power distribution system is important contextual information.

The distribution network takes electricity from the 13.8 kV stations to its destination points (Figure 3). Electric power is routed via Toronto Hydro's feeder lines:

- to customer-owned substations
- to Toronto Hydro's own 4kV stations
- to the TTC substations
- to Toronto Hydro's 600 V stations
- to distribution transformers, at 120/208 V 120/240 V, 240/416 V or 600 V, or
- to low voltage networks

There are approximately 250 customer-owned substations in the City, and each of Toronto Hydro's 13.8 kV stations supplies one or more. These substations are owned by industrial customers, hospitals, schools, and the major downtown office complexes such as the Toronto Dominion Centre or First Canadian Place. Many of the industrial transformers are visible on site, but in the office sector they are typically hidden within the building. To minimize power loss, office building transformation happens in stages. Typically, the substation itself first reduces the voltage from 13.8kv to 600V -- needed to run elevators, fans, air conditioners, etc. Power is then distributed at 600V to each floor, where secondary transformers reduce the voltage to end-user levels of 120/240V.

Toronto Hydro has 33 4kV stations. These are older facilities located mainly in residential areas, with their equipment concealed in inconspicuous buildings (see Map 2 and photographs). Having been reduced in voltage from 13.8 to 4 kilovolts at the station, power is transmitted by underground cable to nearby residential streets, where overhead wires take it to pole-top transformers for reduction to the 120/240 voltages used in people's homes. In cases where commercial or industrial clients are being served, the local transformation may be to a more useful 120/208 (three phase) voltage, or to 600 volts. A lot of industrial equipment demands 600

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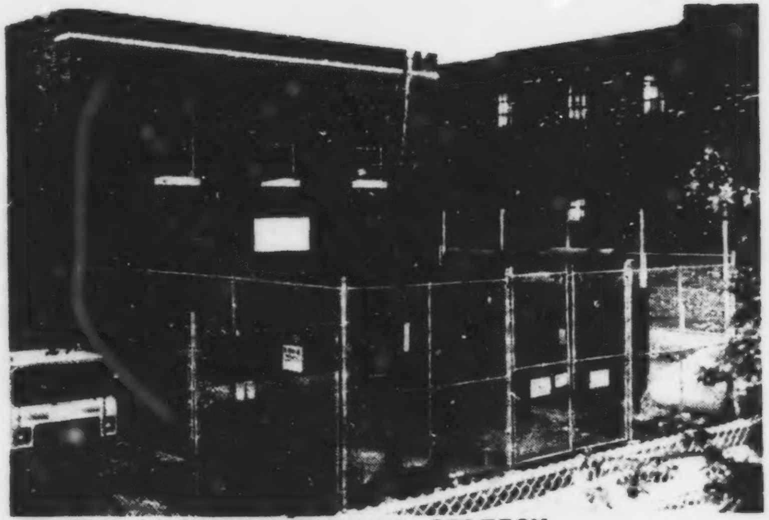
NORTH TORONTO TRACTION STATION
(600 V D.C.) TORONTO HYDRO/T.T.C.

OSSINGTON TRACTION STATION
(600V D.C.) TORONTO HYDRO/T.T.C.



BULWER 600V TRANSFORMER STATION

JOINT ELECTRICAL ENERGY PLANNING STUDY

OTHER CITY TRANSFORMER STATIONS ↑

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volt service; examples include heavy duty air conditioners, compressors or fans. A few customer-owned substations are also supplied via Toronto Hydro's 4kV stations rather than directly from one of the 13.8kV stations.

Although customers supplied via the 4 kV stations do not have inter-connected feeders which provide an "instant cure" for failures, Toronto Hydro has alternative techniques for ensuring that the power supply is quickly re-established. The capability to quickly rearrange overhead wires is inherent to the 4 kV distribution system. Standby feeders exist for most of the 4 kV feeder groups. In the event of a feeder outage, the standby feeder can be used to restore power.

The thirty three Toronto Transit Commission substations are a special part of Toronto Hydro's distribution network. Power at these "traction stations" is not only stepped down from 13.8 kV to 600 volts -- it is also converted from a/c (alternating current) to d/c (direct current) in order to power the City's streetcars, trolley buses and subway trains. TTC substations also provide for the lighting and other electrical needs of most subway stations. In the past, some TTC facilities were supplied by Toronto Hydro's own stations, but the system is now being rationalized so that ultimately all TTC system power will be supplied by TTC-owned substations.

Toronto Hydro owns fourteen 600 volt stations. These are generally in industrial areas, and supply power directly to customers who need it at this higher voltage.

Some distribution transformers take power directly from the 13.8 kV stations and step it down to 120/208 V, 120/240 V or 240/416 V for the end-user. This is an increasingly common practice. In residential areas where the 4 kV system is at capacity and new service is required, Toronto Hydro is now carrying power at 13.8 kV on overhead lines to pole-top transformers in the neighbourhoods. (On commercial strips, such as Bloor Street or Danforth Avenue, an underground version of the same kind of

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SUPPLY OF ELECTRICITY TO A TYPICAL

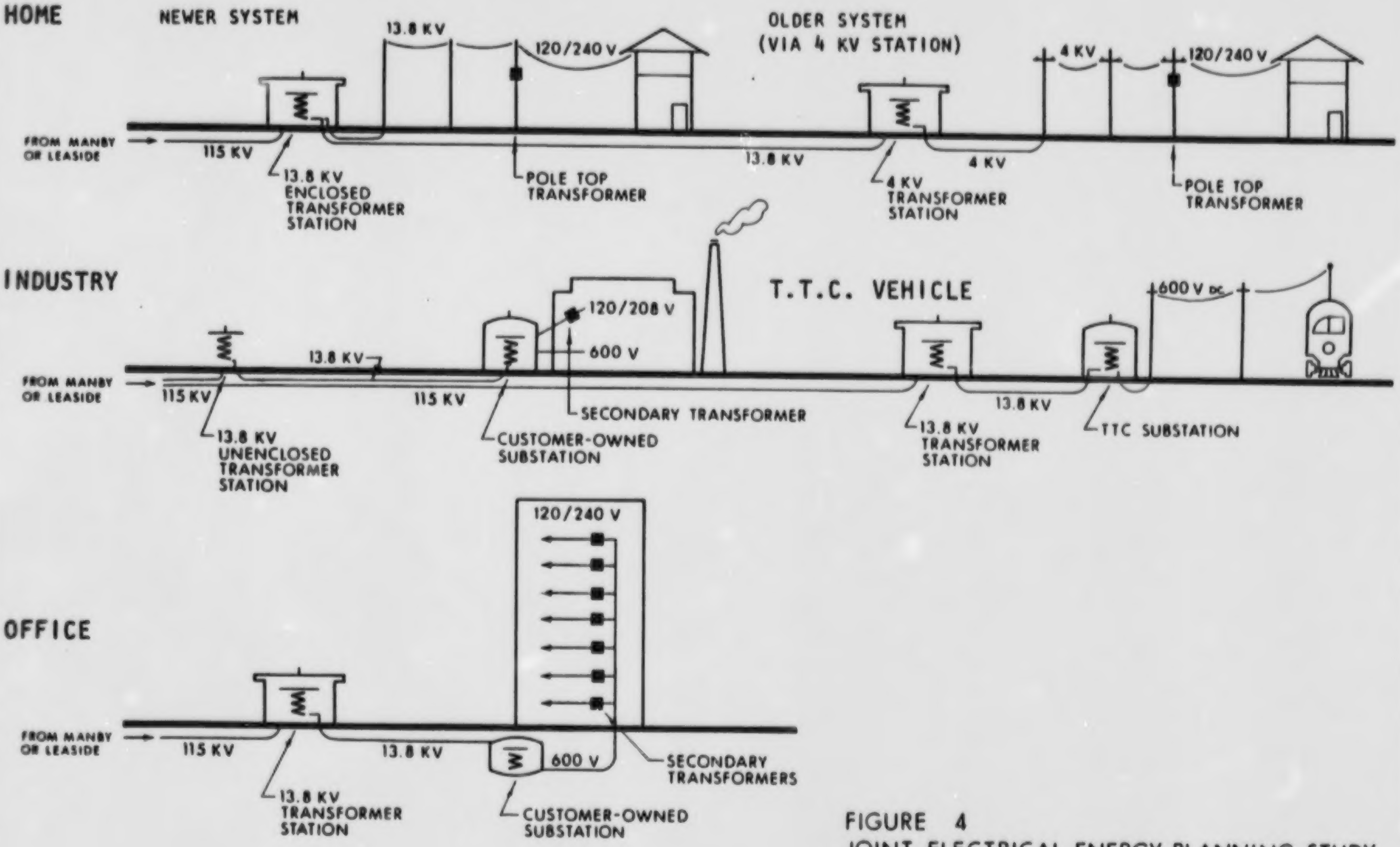
HOME
NEWER SYSTEM
FROM MANBY OR LEASIDE
115 KV
13.8 KV ENCLOSED TRANSFORMER STATION
13.8 KV
120/240 V
POLE TOP TRANSFORMER
OLDER SYSTEM
(VIA 4 KV STATION)
13.8 KV
4 KV TRANSFORMER STATION
4 KV
4 KV
120/240 V
POLE TOP TRANSFORMER
INDUSTRY
FROM MANBY OR LEASIDE
115 KV
13.8 KV UNENCLOSED TRANSFORMER STATION
13.8 KV
115 KV
CUSTOMER-OWNED SUBSTATION
120/208 V
600 V
SECONDARY TRANSFORMER
T.T.C. VEHICLE
13.8 KV TRANSFORMER STATION
13.8 KV
TTC SUBSTATION
600 V DC
OFFICE
FROM MANBY OR LEASIDE
115 KV
13.8 KV TRANSFORMER STATION
13.8 KV
CUSTOMER-OWNED SUBSTATION
600 V
120/240 V
SECONDARY TRANSFORMERS

FIGURE 4
JOINT ELECTRICAL ENERGY PLANNING STUDY

ILLUSTRATION OF ELECTRICITY DISTRIBUTION

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system is used.) Toronto Hydro's recent decision to go this way in supplying extra power needs in the neighbourhoods was based on two considerations:

- 13.8 kV distribution is more efficient than 4 kV distribution, and
- since other utilities are no longer installing 4 kV systems, it is becoming increasingly difficult to get new equipment or replace damaged components.

The 13.8 kV overhead distribution system is a 'loop' design. Both ends of each feeder are connected to a 13.8 kV bus. Since load can be supplied from either end, a problem area can be isolated so that any interruptions are kept to a minimum for most customers.

Low voltage networks are found in areas of the City which are densely built-up and experience heavy power use. The downtown core, roughly between Jarvis and University, is one example. The Yonge and Eglinton area is another. All the transformers in these areas have their secondary cables interconnected to form a grid. Customers are connected to the grid at numerous points. The network is designed so that when a fault occurs the flow of electricity will continue, but using an alternative path. Since most customers are supplied by more than one path, this kind of self-clearing system ensures that few, if any, customers are affected by faults. Hydro customers in other parts of the City do not have this degree of reliability; a fault in the transformer that serves them will cause a power black-out.

A variant on this arrangement is the 'spot' network which serves one or two large customers (typically apartment or office buildings) from two inter-connected transformers in a DESN type arrangement.

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2.4 Planning for Changes in Toronto's Electric Power Supply System

The planning process for future electric supply facilities for the City of Toronto is a continuing joint effort by Ontario Hydro and Toronto Hydro. There are periodic reviews of the extent to which recent past loads have taxed, and forecast future loads will further tax, the capability and limitations of the various transmission lines, transformer stations and other components of the existing supply and distribution systems. These reviews indicate where and when the systems will become inadequate, and the consequences of the inadequacy. The planning process involves the following steps:

An inventory of existing Ontario Hydro and Toronto Hydro facilities and their capabilities is kept, and revised as required by additions or changes. Each transformer, line, circuit breaker and switch is listed, along with its rated capacity, age, and other pertinent information.

Load Records are kept. These show the monthly peak loads on each station and on the individual station buses. Load forecasts for individual station buses are prepared and updated regularly by Toronto Hydro, as discussed in the next chapter.

Based on the most up-to-date load forecasts and the capability inventory of existing facilities, detailed system studies are sometimes carried out. These indicate when certain facilities will become inadequate and identify the need for additional facilities.

Ontario Hydro and Toronto Hydro jointly consider options or alternative methods of dealing with future system inadequacies, including a "do nothing" option. These options are evaluated on a technical and economic basis over both the short and long term, taking into account the sensitivity to changes in basic assumptions, such as future financial discount rates and load growth. For each future system inadequacy, a mutually acceptable solution is established, and a plan schedule is set up for the undertaking.

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Once the utilities have agreed on a solution it must go through an often-complex approval process. In addition to obtaining the necessary approval or permits from the municipal authorities, Ontario Hydro's plans for additional facilities are subject to the provisions of two Provincial Acts: The Planning Act 1983 and The Environmental Assessment Act 1975. Basically:

- The Planning Act 1983 provides that before carrying out any undertaking, Ontario Hydro shall consult with and have regard for the planning policies of any affected municipality. Except for this, planned additions to the power system which would require approval under The Environmental Assessment Act are not subject to The Planning Act.

- The Environmental Assessment Act provides that depending on its nature, a hydro undertaking may require an individual Environmental Assessment, may qualify for the Class Environmental Assessment procedure, or may be exempt. The Minister has the power to exempt any undertaking. The Ontario Cabinet also has the discretion to decide, by regulation, into which of these categories an undertaking will fall. The procedures for both individual and class E.A.s include the involvement of municipal authorities and the public.

- If an undertaking is exempt from The Environmental Assessment Act, it becomes subject to all the provisions of The Planning Act.

A fuller explanation is provided in Appendix E.

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3.0 FORECASTING DEMAND FOR ELECTRICITY

3.1 Computer Modelling - Ruled Impractical

A major focus of the JEEP Committee's work was to forecast long range electrical demand for the City of Toronto. The Committee wanted a forecasting technique which would lend itself readily to sensitivity analysis and would incorporate as many social, economic and technological variables as possible. Obviously a comprehensive computer model would be the ideal vehicle. Some experts in this field were questioned about the feasibility of developing such a model. It was evident from these discussions that the JEEP Committee would have neither the time nor the resources to take on such a comprehensive project. It was agreed that an alternative approach should be found.

3.2 The Land Use Load Density Model - Unsuccessful

Although a comprehensive computer model was impractical, it seemed realistic for the JEEP Committee to develop a partial model to explain load growth. JEEP's Land Use Load Density Model was based on the hypothesis that there is a strong correlation between land use type and peak electrical load per square metre of floor space. By projecting land use change over time, therefore, it should be possible to forecast electricity demand.

To determine the model's validity and usefulness, it was applied to the South Central Area (bounded roughly by Yonge, Bloor, Bathurst and Toronto Bay). The land use stock was divided into eight general categories: apartment, commercial, hospital, hotel, industrial, institutional, strip retail and residential. In each category, a random sample of existing customers was chosen to determine an average demand density (watts per square metre or, for apartments, kilowatts per unit). The total floor area or number of units for each category was multiplied by the respective demand density to estimate the peak load. The peak loads were then combined to estimate the peak load of the South Central Area as a whole.

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It soon became apparent that the model was not going to work as well as had been hoped. The range of densities and standard deviations within most categories was quite large, making it misleading to represent each category by a single average.

Another problem was discrepancies between the addresses used by Toronto Hydro and by the City of Toronto. Matching was done manually, with discrepancies requiring extensive analysis. The time required to match addresses limited the sample sizes, thus reducing the confidence in the average demand densities.

Comparing historic peak loads with those estimated by the Land Use Load Density Model showed up these shortcomings. Applying the average demand densities to existing buildings resulted in load estimates that were far from representative of the actual loads. An analysis of changes in demand densities over time offered little improvement to the reconciliation between the estimated loads based on demand densities and the recorded demand.

The Land Use Load Density Model's crucial second step was estimating future development by land use type, and this also turned out to be problematic. Although there was substantial data to estimate future demand for commercial office space, data were not available to develop confident estimates for the other sectors. Commercial demand represents only about half of the total load in South Central, and considerably less in other parts of the City. Projections for most land use categories would require trend extrapolation of historic development. This procedure would not be much different from Toronto Hydro's traditional forecasting techniques.

In view of these problems, the JEEP Committee decided that the existing load density and land use data could not support a valid forecasting model for peak loads across the City. Work on the Land Use Load Density Model was therefore curtailed, and efforts were directed instead towards refining Toronto Hydro's traditional forecasting techniques.

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3.3 Improving the Traditional Forecast Technique

Toronto Hydro's load forecast method basically involves estimating load growth for each bus at each 13.8 kV station using anticipated new loads, projected general load growth, and planned transfers of load between buses. A regular flow of data has been established between the City of Toronto and Toronto Hydro to share information on known developments and growth expectations of various land use sectors. The City of Toronto information has already contributed significantly to improving the estimates of service dates for large developments. Toronto Hydro and City of Toronto staff have also discussed ways of reconciling the computer data bases in order to improve their record-matching process. This reconciliation, when complete, will enable the two agencies quickly and easily to match information on new and existing buildings.

The JEEP Committee's seminar with electrical industry experts, held late in 1983, was another step towards improved forecasts. This event gave insight to building owners', developers' and consultants' attitudes toward such load variables as energy conservation, co-generation, and load management. The panel members explained the roles of the architects, engineers, and owners in the decision making process which affects a building's design and ultimately its electrical demand (see Appendix B).

Toronto Hydro did extensive work to improve consistency among its engineering load forecasts. A computer program was developed to assist in the preparation of load tabulations. This enables Hydro staff to prepare and alter different scenarios much more quickly than the former manual methods.

The JEEP Committee reviewed the load forecast methodology and made suggestions for further improvements. A better understanding of the variables affecting peak loads is required. Identified variables include weather, electric heat conversions, diversity, (that is, the difference between the coincident peak load for a group of customers and the sum of the non-coincident peak loads of the individual customers in the group) conservation, and the rate at which load build-up occurs in new large buildings. As a result:

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- More emphasis will be placed on establishing growth rates and reconciling actual and predicted loads.
- Toronto Hydro is currently developing a load-weather model and analyzing load build-up and diversity.
- The monitoring of existing and proposed electric heat conversion activity continues to be a priority.
- Toronto Hydro is also analyzing land use load forecasting models available commercially to determine their suitability and benefits.

Results of these efforts will hopefully provide further enhancements to the load forecast methodology.

3.4 The 13.8 kV Bus Load Forecasts

Toronto Hydro experiences peak loads in both the summer and winter seasons, due to air-conditioning and electric heating respectively. Forecasts for both seasons are prepared because the limitations of the supply system components vary from summer to winter (the natural cooling which occurs in wintertime allows higher electrical loads to be carried). For load forecasting purposes, summer includes the months June to September and winter includes the months December to February. To identify loading problems, the peak loads are compared to the capacities of the limiting components. (Usually the limiting component is either the 13.8 kV switchgear, the bank secondary cables, or the 115 kV to 13.8 kV transformers.)

Summer and winter load forecasts are prepared for each 13.8 kV bus. The starting points for the load tabulations are the most recent season peak loads. These loads are adjusted if abnormal weather conditions existed during the peaking period. Due to our limited understanding of the absolute effects of weather on electric load, the adjustments are quite subjective.

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The load forecasts are based on a time-trend method that extrapolates from the most recent peak loads. Estimates of future peak loads are calculated by adding base or area load growth, proposed services and load additions, estimates of electric heat conversions, and proposed load rearrangements, using the methods described in the next few sections.

The following example illustrates one year ahead projection of peak load on a typical bus at one of the 13.8 kV stations:

Winter 83/84 - Actual Peak Load	32.5	MVA
Base growth 1.0%	.3	
New service	.3	
Existing service - added load	.2	
Electric heat	.2	
Load transfer - from adjacent bus	8.0	
Winter 84/85 - Projected Peak Load	41.5	

3.5 Base and Area Load Growth Rates

Two different growth rates are calculated from past records of bus peak loadings and used in the forecasts. The area load growth rate, which is simply the average annual change in peak load, is not used until the later years of the forecast period.

For forecasting load in the first few years, Toronto Hydro uses a base load growth rate which is calculated by excluding from the load change in each year all loads greater than 200 kVA added during that year. The resulting lower rate of increase accounts for the multitude of small services and load additions to existing services, but not for large loads. In the forecast, all known proposals for new large load increases are itemized and assigned to a particular bus. The forecast for that bus will consist of the base load growth rate plus these known new loads. (Plus an electric heating load estimate, if applicable).

Since information on proposed developments and load additions is limited to just a few years ahead, Toronto Hydro's staff switch from the base growth rate to the area growth rate for the first year in which information on specific new loads appears unreliable or incomplete, or is not available.

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3.6 Proposed Services and Load Additions

The electrical consultant for a large development usually contacts Toronto Hydro one to three years before service is required. Details on the location, use, and load are used to estimate the service date, the supply bus, and the load build-up of the project. Information from the Planning and Development Department of the City of Toronto is used to improve the estimate of the service date and the timing of the load build-up.

A substantial portion of Toronto Hydro's load growth results from discrete new loads being added by existing customers. Owners and consultants contact Toronto Hydro to request additional capacity and give details of their proposals. The treatment of added loads is quite similar to that of new services. Estimates of service date and load build-up are made and included in the load tabulations.

3.7 Electric Heat Conversions

The impact of large-scale electric heat conversions is a new phenomenon occurring primarily in the residential sector. The effects of such conversions were first detected in 1979. Toronto Hydro now carries out annual customer surveys and impact studies to provide information on the current and potential effects of electric heating. Estimates of conversion activity have been made for the residential areas of Toronto based on these studies. The estimates anticipate that new load resulting from electric heat conversions will taper off in the early 1990's. (For further information on electric heat conversions, see: Residential Load Growth Study, Toronto Hydro, July 1983).

Since electric heat has a significant impact on Toronto Hydro's distribution system, estimates of its load impact have been separated from the 13.8 kV bus growth rates. This approach makes it easy to apply sensitivity analysis to the electric heat projections, or to modify them based on new data from Toronto Hydro's annual surveys. Electric heat conversion estimates are included in the winter load tabulations of 13.8 kV buses supplying residential areas. On-going monitoring of electric heat activity indicates that forecasts to date have been fairly accurate.

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Toronto Hydro expects that the impact of electric heat conversions in the commercial sector will be minimal. It is assumed that the effects of the conversions in this sector are included in the area growth rates.

3.8 Proposed Load Rearrangements

The bus forecasts include proposed load rearrangements that are necessary to alleviate potential overloads. Typically, load rearrangements involve transferring existing customers from heavily loaded buses to lightly loaded buses. Due to the uncertainties about both load growth and the future physical layout of the distribution system, load transfers are usually only proposed for the next five years. However, load rearrangements proposed to occur after five years are included if they have been identified and appear to be feasible.

Appendix F explains some of the more technical aspects of the load forecast method described in Sections 3.3 - 3.8.

3.9 Use of Bus Forecasts

The 13.8 kV bus forecasts appear in Appendix G. These are used directly to decide on new facility needs at Toronto Hydro's 13.8 kV stations. They are then aggregated and reduced by appropriate coincidence factors, to take account of the fact that several buses seldom peak at the same time. The aggregate forecasts are used to decide if additional 115-13.8 kV transformer capacity is needed, if there need to be changes at Ontario Hydro's 230-115 kV stations (Manby and Leaside), or if any part of Ontario Hydro's 115 kV transmission system needs additional capacity.

3.10 Energy Conservation Impact

Energy conservation measures have been widely promoted and carried out for several years now. Since they are based on recent experience, the growth rates used in JEEP's forecasting methods implicitly assume that energy conservation in the future will continue at the same rate as it has in the recent past. This may well mean that the forecasts are on

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the low side with respect to energy conservation - that is, assuming conservation will do more to reduce electricity consumption than will actually be the case. Many Hydro customers have already implemented most of the cheap and easy (low cost/no cost) energy conservation measures available to them. Additional changes are likely to cost more and have longer payback periods, and building owners may be reluctant to invest in such measures. This is particularly true in the downtown office sector where space is increasingly rented out under "triple-net" leasing agreements. These essentially make the tenant responsible for energy charges, thus eliminating any incentive for the landlord to spend money on conservation; meanwhile, since many conservation measures in large buildings must apply to the building as a whole, the tenant is in no position to make improvements.

Other trends, such as office automation, could also contribute to higher than expected growth rates. These uncertainties underline the need for an ongoing monitoring process.

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4.0 EXPECTED NEW FACILITY NEEDS

4.1 Forecasts for 13.8 kV Station Loads

Tables 1 and 2 set out the JEEP Committee's forecast loads for each of Toronto Hydro's 13.8 kV stations. Projected loads for each bus were forecast using the method described in Chapter 3. Station level forecasts were then prepared by adding all of the bus loads for a station, then reducing the total by a coincidence factor (derived by averaging historic coincidence records for that station) to reflect the fact that buses experience their peak loads at different times.

4.2 Need for New Facilities at 13.8 kV Stations

The first columns in Tables 1 and 2 show the capacity of the existing facilities (transformers and switchgear) at each station. Summer capacities (Table 1) are generally lower than winter capacities, because most electrical equipment can withstand heavier loads when the ambient temperature is low.

Capacity is calculated by adding the Limited Time Ratings (LTR's) of all buses at a station, then multiplying by .95. This reduction factor is based on Hydro's past experience that when the peak load on a 13.8 kV transformer station reaches about 95% of the sum of its individual bus LTR's, the loading on one or more of the buses will reach or exceed 100% of its LTR and, therefore, additional transformer capacity will be required. This comes about mainly because it is impossible to distribute the loads on individual 13.8 kV station buses to match their respective LTR's exactly. Individual customer loads may exceed 5 MVA, and network system loads could be from 10 to 25 MVA. It is often not feasible or economic to transfer loads from one bus to another. As a result, the load on one station bus could approach its LTR while other buses have spare capacity that cannot be used to relieve the more heavily loaded bus.

The capacity calculation assumes single contingency outage conditions. That is, additional facilities are assumed to be needed when load grows to the point where it exceeds the rating of existing facilities (transformers, lines, switches etc.) with any one element out of service.

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TABLE 1

TRANSFORMER STATION SUMMER PEAK LOAD FORECASTS (MVA)

Station	95% of existing LTR	Sum of Coincident Station Bus Loads Based on Load Forecasts for Individual Buses and on Historical Coincident Factors																
		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Basin	85	68	71	76	78	85	88	91	94	96	99	102	105	109	112	115	119	122
Bridgman	170	143	145	151	158	162	167	171	175	180	185	190	195	200	205	211	216	222
Carlaw	85	57	58	61	63	61	62	63	64	66	67	68	70	71	72	74	75	77
Cecil	176	128	133	136	138	140	138	140	143	146	149	152	155	158	162	165	169	172
Charles	169	141	144	150	160	166	173	179	185	191	197	204	211	219	226	234	242	250
Dufferin	91	78	85	91	95	104	108	111	114	116	118	121	123	125	128	130	133	136
Duplex	136	100	103	108	111	114	121	126	130	133	137	141	146	150	155	159	164	169
Esplanade	123	103	106	114	117	121	125	128	131	135	138	142	146	150	153	158	162	166
Gerrard	66	51	54	54	51	50	51	52	54	55	56	58	59	61	62	63	65	67
Glengrove	80	50	50	48	49	51	49	50	52	54	55	56	59	60	62	64	66	68
John	302	254	276	287	300	314	324	335	345	355	366	378	390	401	414	427	440	455
Main	73	57	58	58	61	62	64	65	67	68	69	71	72	73	75	76	78	80
Strachan	122	96	99	102	105	109	112	115	118	121	124	127	131	134	138	141	145	149
Terauley	223	177	185	192	203	213	233	243	250	258	266	274	282	291	299	308	317	327
Wiltshire	125	106	107	106	101	102	101	103	105	107	109	112	114	116	119	121	123	126

Note: A capacity increase is expected to be required at the summer critical stations in the years indicated by underlined loads.

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TABLE 2

TRANSFORMER STATION WINTER PEAK LOAD FORECASTS (MVA)

Station	95% of existing LTR	Sum of Coincident Station Bus Loads Based on Load Forecasts for Individual Buses and on Historical Coincident Factors 1983/4	1984/5	1985/6	1986/7	1987/8	1988/9	1989/0	1990/1	1991/2	1992/3	1993/4	1994/5	1995/6	1996/7	1997/8	1998/9	1999/0
Basin	93	65	71	78	81	88	91	94	97	100	104	107	110	113	117	120	124	128
Bridgman	186	139	143	153	161	166	171	176	181	187	193	198	205	208	214	219	225	231
Carlaw	89	66	69	75	77	77	79	81	83	86	88	90	92	94	96	97	99	101
Cecil	194	113	119	122	123	127	131	130	134	139	143	148	152	156	161	166	171	176
Charles	186	143	146	153	165	171	179	185	191	197	204	211	218	226	234	242	250	259
Dufferin	103	94	105	115	131	138	146	152	157	162	167	173	176	180	183	187	191	195
Duplex	147	102	106	114	117	121	131	137	142	147	152	158	163	168	173	178	183	189
Esplanade	125	94	99	107	111	115	118	121	125	128	132	135	139	143	146	150	154	158
Gerrard	83	73	74	77	75	76	79	82	85	89	92	96	98	100	103	106	109	111
Glengrove	95	67	70	68	71	75	74	78	82	87	91	95	98	101	104	107	110	114
John	305	210	228	247	258	269	279	288	296	305	314	323	332	341	351	362	372	383
Main	77	71	74	76	81	85	90	94	98	103	107	112	115	118	121	124	128	131
Strachan	125	108	111	115	120	125	130	134	138	142	147	151	155	158	162	165	169	173
Terauley	230	159	167	172	180	189	202	216	225	232	239	247	254	261	269	277	286	294
Wiltshire	147	129	131	133	129	132	135	140	146	152	158	164	168	171	174	178	182	185

Note: A capacity increase is expected to be required at the winter critical stations in the years indicated by underlined loads.

Tables 1 and 2 show the year in which additional facilities will be needed at each station to accommodate the forecast station loads. The timing of these requirements could be earlier or later than indicated, depending on the actual load growth on each station and the extent to which existing capacity and load transfers can be utilized.

If the JEEP Committee's calculations and assumptions are correct, electrical loads at almost all of the City's 13.8 kV stations will exceed the capacity of the existing equipment before the year 2000.

4.3 Solutions to Capacity Problems at the 13.8 kV Stations

If the bad news is that most 13.8 kV stations will hit capacity during this century, the good news is that there appear to be solutions available which will allow sufficient new capacity to be added on the existing station premises. This is a tentative conclusion, and will have to be monitored as load forecasts change and further technical studies are carried out. It may be that there are better solutions, from the point of view of efficiency and cost effectiveness. In view of the utilities' past problems with siting new stations, however, it is an encouraging finding.

Table 3 sets out possible responses to each of the identified stations' overload conditions. While all of these proposals are considered feasible, it is not known at this time if they are the most appropriate choices. For example, both John TS and Terauley TS will require relief in the 1990's; instead of installing additional transformation at these stations, as suggested in Table 3, it may be more economical and desirable to establish a new transformer station in south-central Toronto and transfer some loads from the existing stations to the new station.

Table 3 also indicates the possible impact on the public of the listed methods of increasing capacity at each station. Additional transformer noise is not noted as an impact since it is Ontario Hydro's policy to assess audible noise emissions from all new or upgraded facilities and, where these are found to be excessive, to take all practical measures to reduce them to acceptable levels.

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TABLE 3

POSSIBLE FUTURE 13.8 kV TRANSFORMER STATION CAPACITY INCREASES TO ACCOMMODATE FORECAST LOADS

Station	Expected Overload Year	Possible Method of Increasing Station Capacity	Possible Impact on Public
Basin TS	1989	Supply a new bus from the idle windings of two existing transformers.	The new bus will be enclosed in a masonry building.
Bridgman TS	1990	Increase the LTR of an existing bus utilizing the idle winding of an existing transformer.	No visual impact since there are no additional facilities.
	1995	Replace two existing transformers with two higher rated units and install a new bus.	Little visual impact since replacement transformers are only slightly larger than existing units and the new bus will be enclosed in a building.
Carlaw TS	1993	Replace two existing transformers with two higher rated units and uprate two existing buses.	Little impact since this station is enclosed in a masonry building.
Charles TS	1989	Replace two existing transformers with two higher rated units, and uprate two existing buses.	Little impact since this station is enclosed in a masonry building.
	1996	Replace two existing transformers with two higher rated units and uprate two existing buses.	Same.

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TABLE 3

POSSIBLE FUTURE 13.8 kV TRANSFORMER STATION CAPACITY INCREASES TO ACCOMMODATE FORECAST LOADS

Station	Expected Overload Year	Possible Method of Increasing Station Capacity	Possible Impact on Public
Dufferin TS	1985	Install two new transformers and a new bus. One winding on each transformer would be left idle.	Little impact. This station is housed in a masonry building.
	1990	Connect a new bus to the idle windings.	Same.
Duplex TS	1992	Connect a new bus to the idle windings of two existing transformers.	Little impact. This station is enclosed in a masonry building.
Esplanade TS	1989	Rebuild the existing outdoor station to a totally enclosed station. Replace the existing four transformers with two higher rated units.	Improved visual impact and reduce transformer noise since the rebuilt station will be enclosed in a masonry building.
	1993	Add a 3rd transformer and a new bus.	Small impact. Enclosed station.
John TS	1988	Replace an existing transformer with a higher rated unit and install a new bus.	The transformer would be outdoors on existing property the new bus would be enclosed in a masonry building.
	1993	Replace two existing transformers with two higher rated units and install a new bus.	Same.

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TABLE 3

POSSIBLE FUTURE 13.8 kV TRANSFORMER STATION CAPACITY INCREASES TO ACCOMMODATE FORECAST LOADS

Station	Expected Overload Year	Possible Method of Increasing Station Capacity	Possible Impact on Public
Gerrard TS	1990	Replace two existing transformers with higher rated units.	Little visual impact since replacement transformers are only slightly larger than existing units. Two lanes of the Don Valley Parkway would have to be closed for the transformer exchange.
Glengrove TS	1994	Replace the existing transformers with two higher rated units and install a new bus.	Little impact since this station is enclosed in a masonry building.
Main TS	1986	Connect a new bus to two existing transformers.	New bus would be installed in extension of existing masonry building.
Strachan TS	1988	Connect a new bus to the idle windings of two existing transformers.	New bus would be installed in existing masonry building.
Terauley TS	1989	Increase LTR of two buses by uprating series limiting components.	This station is enclosed in a masonry building.

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TABLE 3

POSSIBLE FUTURE 13.8 kV TRANSFORMER STATION CAPACITY INCREASES TO ACCOMMODATE FORECAST LOADS

Station	Expected Overload Year	Possible Method of Increasing Station Capacity	Possible Impact on Public
Terauley TS	1992	Add two new transformers and a bus and associated 115 kV supply cable from Leaside TS. One winding on each transformer would be left idle.	Same.
	1999	Connect a new bus to the idle windings.	Same.
Wiltshire TS	1991	Replace two existing transformers with two higher rated units and add a new bus.	Little visual impact since new transformes would be only slightly larger than existing units and the new bus would be enclosed in a masonry building.

Note: See Section 4.3 for explanation re possible noise impacts.

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4.4 A Possible New Station: The Railway Lands Solution

Members of the JEEP Committee were conscious throughout the study that a need may emerge for a new transformer station to service South-Central Toronto. During the study's first year, in fact, Ontario Hydro and Toronto Hydro were jointly engaged in preparing a 'Statement of Need' report - the first step towards gaining approval for a new South-Central transformer station under The Environment Assessment (E.A.) Act. A draft of this report was submitted to the JEEP Committee for review and comment, and the Committee recommended a procedure whereby the public hearing phase of the E.A. process could be carried on in tandem with its own work on developing forecasts.

In early 1983, however, Ontario Hydro and Toronto Hydro decided to suspend work on the South-Central Study for the time being. This decision reflected a reduction in forecast growth over what had previously been assumed, and the recognition that alternatives such as those set out in Table 3 would allow further postponement of a new station.

Meanwhile, the JEEP Committee had informally concluded that the proposed development of the Railway Lands area would provide opportunity for a new transformer station to be built in a way that would have minimal impact on residents and businesses in already built-up parts of the City. Conceptually, the solution would involve designing a station into the public park that is proposed to be built in the centre of the Railway Lands development area, adjacent to the C.N. Tower. By taking advantage of grades where the park will abut the main rail lines, a transformer station could be concealed underground yet be accessible at grade from one side (making it easy to install or remove equipment).

The JEEP Committee proposes that the option of building such a new transformer station be protected in future planning for the Railway Lands. Although such a recommendation should not (and cannot) short circuit the required environmental assessment process, it will at least ensure that what now appears to be an attractive option is not lost.

4.5 Projections of Load on the Overall Supply System

The 13.8 kV stations are not the only major elements of Toronto's electrical supply system likely to be stressed by future load requirements. Ontario Hydro's 115 kV transmission lines and cables which transmit power into the stations, as well as the 230-115 kV stations at Manby and Leaside, will also have to accommodate significantly increased loads if the JEEP Committee's forecasts prove correct.

To determine the impact of forecast load growth on the Ontario Hydro supply system, Toronto Hydro's future overall system peak loads were estimated. Starting with the individual bus forecasts, described in Chapter 3, the annual load growth on each bus was first reduced by 10% to reflect that not all forecast load growth at every location is expected to materialize. Two factors were then applied to the sum of the reduced bus peaks for each station in the following formula:

Sum of reduced bus peak loads x C1 x C2 = Projected station peak load coincident with Toronto Hydro's system peak

In this formula, C1 is the recorded historic bus coincidence factor for the station (also used in Section 4.1) to reflect that the individual buses experience their peak loads at different times. Similarly, C2 is the recorded historic station coincidence factor to reflect that the individual stations peak at different times and that the Toronto Hydro system peak load is lower than the sum of the station peaks. Coincidence factors C1 and C2 differ for each station and vary from summer to winter. Average values for C1 and C2 for the fifteen Toronto stations are 97% and 96% respectively in summer and 96% and 94% respectively in winter.

Load forecasts for each of the fifteen stations were calculated as described above for each year. The sum of these station forecasts equals the estimated total Toronto Hydro system load. The load estimates so derived increase from 1511 MVA in the

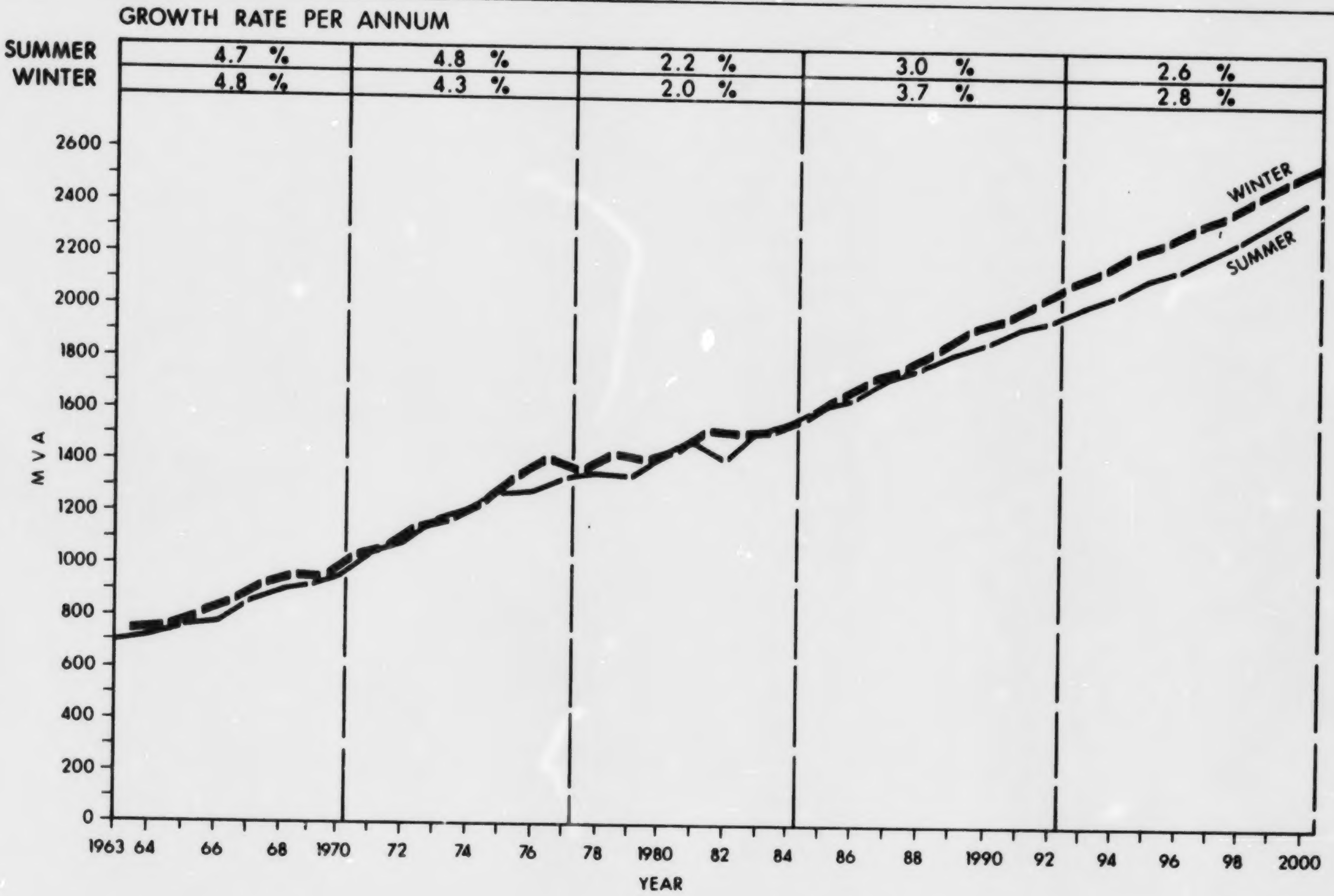

FIGURE 5
JOINT ELECTRICAL ENERGY PLANNING STUDY

TORONTO HYDRO SYSTEM PEAKS:
ACTUAL & PROJECTED

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TABLE 4

Possible Future 230/115 kV Transformer Capacity Increases to Accommodate Forecast Loads

Station	Expected Overload Year	Possible Method of Increasing Station Capacity	Possible Impact on Public
Manby - West	1986	Replace existing 215 MVA transformer T2 with a 250 MVA unit. This will increase the 10-day summer LTR from 525 MVA to 640 MVA.	The replacement transformer will be outdoors on existing station property.
	1997	Install 4th 250 MVA transformer to increase the 10-day summer LTR to 960 MVA.	The new transformer will be outdoors on existing property.
Leaside TS	1991	Install 6th 250 MVA transformer and associated 230 kVA supply circuit from Cherrywood TS to increase the 10-day summer LTR from 1220 MVA to 1500 MVA.	The new transformer will be outdoors on existing station property. The new circuit will be on existing right-of-way.
	1999	Install 7th and 8th 250 MVA transformers and associated 230 kV circuits from Cherrywood TS. Since more than six transformers cannot be paralleled at Leaside due to short-circuit restrictions, it will be necessary to split the 115 kV switch-yard into two sections at that time. Future detailed studies will be required to establish the number of transformers that should be connected to each section.	The new transformers will be outdoors on existing station property. The new circuits will be on existing right-of-way.

Note: Both these stations are located outside the City of Toronto.

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TABLE 5

Possible Future 115 kV Transmission Line Capacity Increases to Accommodate Forecast Loads

Line Station	Expected Overload Year	Possible Method of Providing Station Capacity	Possible Impact on Public
Leaside TS x Charles TS	1987	Install an eight-breaker 115 kV ring bus at Cecil TS to connect together the six 115 kV cable circuits terminating at this station. This permits the utilization of spare capacity in the existing circuits and has the effect of providing increased transmission capacity. This installation has been authorized.	The new switching facilities will be housed in an extension of the existing enclosed masonry building.
Cecil TS x Terauley TS	1988	Replace a short section of circuit A9C to increase its emergency rating from 180 to 260 MVA.	This circuit is underground on road allowance.
Leaside TS x Charles TS x Terauley TS	1992	Install a new 115 kV cable circuit to supply a new DESN station at Terauley TS and to unload circuits L9X and L12K.	An existing spare pipe between Leaside TS and Balfour Jct. will accommodate the new circuit in this station. The remainder will be on road allowance.
Manby - West x Riverside Junction	1992	Uprate the existing four overhead 115 kV circuits. (This line is entirely within the City of Etobicoke).	A study of these circuits will be carried out to determine the amount of work required and the extent of uprating that is possible.

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TABLE 6

Other Probable System Changes

Section	Expected Date	Nature of Change	Possible Impact on Public
Warden TS	1987	Convert this 115-27.6 kV station which supplies Scarborough PUC, for 230 kV operation. This conversion will reduce the loading on the Leaside 230-115 kV transformers.	The converted outdoor station will be on existing property.
Bridgman TS	1988	This station is now normally supplied from Manby - East with back-up supply from Leaside TS. It is planned to transfer its normal supply to Leaside TS with back-up from Manby to relieve the normal loading on Manby - East.	No impact.
Horner TS	1988	Convert this 115-27.6 kV station, which supplies Etobicoke PUC, for 230 kV operation. This conversion will reduce the loading on Manby - West.	The converted outdoor station will be on existing property.
Scarborough TS	1999	Convert this 115-27.6 kV station for 230 kV operation. This will reduce the loading on Leaside 230-115 kV transformers.	The converted outdoor station will be on existing property.

Note: Except for Bridgman, these stations are located outside the City of Toronto.

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summer of 1983 to 2412 MVA in the summer of 2000, and from 1509 MVA in the winter of 1982/83 to 2581 MVA in the winter of 2000/01. Figure 5 shows the Toronto Hydro system peak forecast to the year 2000. The calculated (reduced) station peaks are shown in Appendix I.

Load estimates were similarly calculated for the stations in other municipalities which are supplied from Leaside TS and Manby TS. The impact of the forecast peak loads on the supply system was tested using a computer load-flow program. The results identified the 230-115 kV transformers and the 115 kV supply circuits that will become overloaded under single element outages.

The absolute amount of increase projected for the total system may seem large - the JEEP Committee is suggesting that peak electrical use by the end of this century will be up by a factor of two-thirds. However, this forecast incorporates a significant slowdown over rates of growth prior to the past six years. As Figure 5 shows, growth in peak electrical usage approach five per cent per year throughout the sixties and early seventies. Since about 1977 this has dropped back sharply to little more than two per cent. The JEEP forecast, based on past growth, imminent new loads, and the impact of electric heating, suggests future growth rates only slightly above the recent past for summer loads; for winter the forecast rate is about mid-way between that of the recent past and that of the early seventies.

4.6 Solutions to Capacity Problems in Ontario Hydro's Supply System

The results of this analysis are listed in Tables 4 and 5. Also listed in Tables 4-6 are possible methods of increasing capacity to cope with each projected overload situation, as well as the possible impact on the public of these methods. All the solutions listed are considered feasible, but other alternatives will also have to be studied before settling on the plan to be adopted. For example, it might be possible to put new transformers into some of the City's existing 13.8 kV stations so they could receive power at 230 kV; this would reduce the load on Manby and/or Leaside as well as on the

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existing 115 kV transmission lines. Alternatively, a third 230/115 kV transformer station could be established to serve the City (at the old Hearn Generating Station site, for instance), rather than increasing capacity at Manby and Leaside as suggested in Table 4. Various alternatives such as these will be investigated.

A computer load flow study was carried out for the forecast loads in the year 2000, assuming the system is changed in accordance with the possibilities indicated in Tables 3-6. The study showed that the assumed system would be adequate to supply the forecast load growth. However, as indicated earlier, detailed studies would be carried out before each change. It is possible that these studies would show that a proposed change is impractical, or that some alternative plan would work better.

It should be noted that current planning is based on maintaining acceptable supply with only one critical element of the supply system out of service (the 'single contingency outage' condition). With the increased size and density of the electrical load by the year 2000, it may be desirable to provide for the simultaneous outage of more than one critical element. Any policy decision of this sort would clearly change both the nature and timing of additional supply facilities.

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5.0 ARE THERE ALTERNATIVES TO NEW FACILITIES?

5.1 A Cursory Review - Not a Comprehensive Study

Are there alternatives that are better than increasing the capacity of Toronto's electric supply system? Or if not, is it at least possible to find workable, cost-effective strategies which will defer the need for new facilities into the distant future? These questions surfaced repeatedly at the JEEP Committee's meetings.

The JEEP Committee concluded that a full scale cost/benefit study of alternatives was beyond its mandate and resources. Such a study would evaluate a range of available load abatement measures, and compare the cost of the load reduction achievable with the savings that would be realized by deferring or eliminating new supply and distribution facilities and new generating capacity. While a study of this type would likely yield useful results, it would need to form part of a broader exercise than the one reported here.

What the JEEP Committee did, however, was to carry out a rather cursory examination of a series of load abatement measures and to pass comment on which ones appear worthwhile to pursue further.

5.2 Options Include Regulations, Incentives

The options discussed in this chapter span a range from 'hard' regulatory measures, which would impose requirements on users or limit their options, to 'soft' measures that merely provide an incentive to reduce overall or peak period electricity consumption.

The policy options listed here were discussed by the JEEP Committee. Some ideas arose from two major seminars: the one reported in Appendix B, and another organized by the City's Planning and Development Department to explore the potential for incorporating conservation initiatives in the development of the Railway Lands.

Both seminars suggested that the incentive-type policies would be the more appropriate route to follow. Arguments were made for avoiding draconian measures, particularly restrictions affecting the physical design of new buildings or measures that would prolong the development approval process.

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5.3 Requiring Energy Budgets in the Development Approval Process

The Energy Budget concept involves a municipality setting maximum consumption targets for various types of buildings. New development proposals would either have their energy consumption estimated by municipal staff to see whether they met the 'target' energy budget, or an 'impact statement' prepared by the developer would have to accompany each development application. Energy targets would be expressed in terms of watt-hours per square metre (or B.t.u.'s per square foot). Alternatively, and more to the point in terms of electrical facility planning, power targets related to peak demand could be set.

There are several criticisms of this kind of technique. An evaluation based on the type of preliminary drawings generally submitted under site plan control, (the most likely mechanism) could be of questionable validity. To be effective, a power budget policy would have to be enforced through demand measurements after completion. Such monitoring would pose a problem as large commercial buildings can take up to three years to construct, and several more before full occupancy is reached. The JEEP Committee also found, through its forecasting exercise, that the final demand levels for quite similar buildings can vary significantly depending on how the building is operated.

Suitable 'penalties' for failing to perform to the design level are another issue. First, special legislation would be required before a municipality could refuse a building permit solely because the evaluated design consumption level did not meet its policy guidelines. Second, it would be difficult to arrive at suitable penalties when a building's actual consumption is likely to vary significantly from the design levels.

Other concerns include the need to ensure that such energy demand requirements do not adversely affect non-energy considerations (e.g. by limiting design options), and the cost of an energy budget procedure (to municipality, developer, or both). Moreover, such budgets would not impact on existing buildings (which will continue to generate the great majority of electrical demand).

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5.4 Mandatory Use of District Heating

Toronto's existing district steam system provides an option for displacing other heating sources. However, peak electrical demand in the downtown area is based on the space cooling load in office buildings. To displace this load, steam would have to be used to cool buildings as well as heat them. The regulatory policy to be considered here would be a legislated reqirement that new development proposals must hook up to the steam system. This would address two potential City objectives:

a) providing an expanded market for the steam generated by the refuse burning steam plant proposed to be built in the Port area, and

b) by using steam generated from garbage, reducing the conventional fuel requirements of new development.

Beyond the question of whether technology can be economically applied to utilize steam for space cooling, the JEEP Committee believes that such a regulation would be politically unacceptable. Toronto Hydro staff pointed out that their utility would have to incur the costs of supplying electric service to a new development in any event and suggested that it would be inappropriate to regulate how that service can be used.

5.5 Surcharges for Customers Adding Significant New Load

Another strategy involves the use of surcharges for electrical applications likely to add significantly to peak demand. An example would be a surcharge for homeowners who convert to electric heating. (This item was raised during a discussion of the Toronto Hydro home heating survey results).

For new buildings, a surcharge would be an economic incentive toward more efficient design. By charging a very large hook-up fee that would vary with the anticipated peak demand, more efficient applications might be encouraged. This would also be a very effective way of recovering the capital costs for new facilities.

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A type of surcharge was actually used by Ontario Hydro in the past. From 1924 until 1958, prohibitively high monthly rates were imposed on consumers who used electricity for space heating. This was done with the express intent of discouraging space heating, because of the high capital costs foreseen for generation, transmission and distribution if it became a widespread practice.

Today, however, the surcharge concept is not viewed favourably by the utilities. For one thing, unlike other heating sources such as natural gas, electricity must be supplied to homes and other buildings for general service. It would be difficult for the utilities to justify a surcharge for electric heat or other projected heavy loads if they experience little or no added capital cost to the utility in 'hooking up' the customer. Time-differentiated rates may be a better way of addressing this issue (see Section 5.7).

5.6 Using Electrical Load Management Techniques

Load management is a collection of techniques for changing electrical loads and the way they impact on the distribution system. Peak shaving, peak shifting and capacity/load shifting are all established load management activities.

Load management provides numerous benefits. Overloading of equipment and outages can be avoided by suppressing peak loads. Shifting loads to different supply points can reduce the length of outages. Reducing or controlling peak load growth to defer or eliminate the need for added capacity can save the utilities capital costs.

Toronto Hydro currently engages in a number of load management activities. Over 54,000 residential water heaters are directly controlled by Hydro, which regularly reduces their power supply ("load shedding") to reduce the system peak. Ten medium-sized customers are each supplied from two stations; this dual supply means that reserve capacity at one station can be used when another station is approaching overload.

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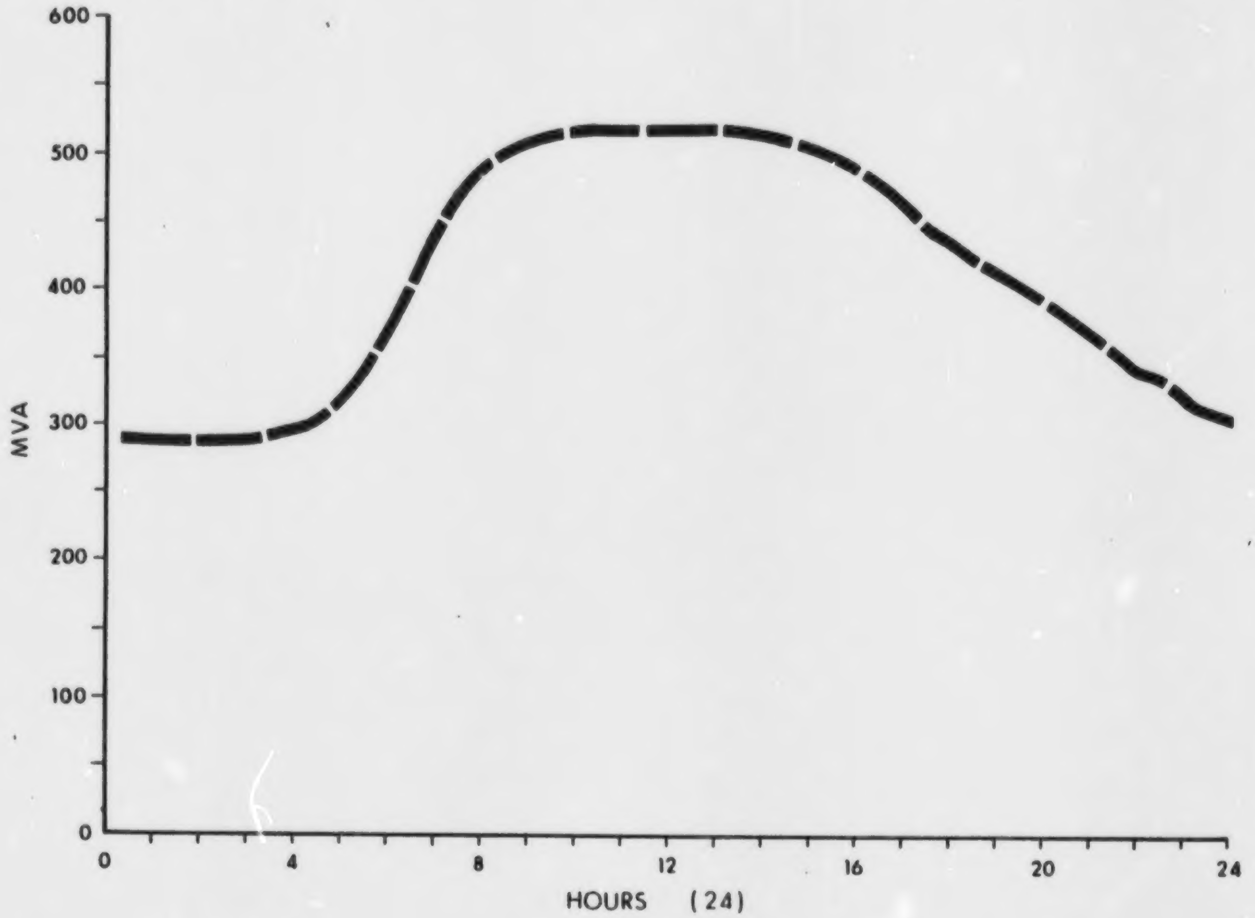

FIGURE 6
JOINT ELECTRICAL ENERGY PLANNING STUDY

DAILY PEAK LOAD CURVE - DOWNTOWN TORONTO
TERAULEY, CECIL AND JOHN STATIONS
FRIDAY, JULY 15, 1983

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Load management is not confined to the utility. Increasing numbers of hydro customers are installing peak load control systems to manage their own loads and so reduce their electricity bills.

These existing load management activities are important, but they will not significantly alter the requirement for additional 13.8 kV transformer capacity in downtown Toronto. Residential water heater control has no impact in this part of the City, and due to technical operating reasons, installing numerous dual station supplies is not attractive. In addition, the downtown daily peak load curve is quite flat, lasting over five hours (Figure 6). Non-essential loads suitable for shedding or shifting are few. During peaking periods, cycling by air conditioners is at a minimum, resulting in very little diversity and limiting the opportunities for effective control of load. All these factors mean that the amount of downtown load that could be controlled at peak times would be minimal.

Notwithstanding this conclusion, more extensive use of modern load management techniques by Toronto Hydro could significantly reduce loads in parts of the City outside the downtown core, reduce the overall system peak, and would have at least some impact on downtown demand. For this to occur:

- Toronto Hydro would need an automated distribution system - basically a set of computerized monitoring and control facilities which would automatically and rapidly transfer loads from overloaded buses to buses with reserve capacity;

- Toronto Hydro would need a control system, analogous to that used for water heaters, that would control the on and off cycles of customer's air conditioners, heat pumps, plenum heaters, etc. to minimize the overall system peak load.

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At present, the technology to carry out this type of load management is in its infancy and the costs are high. However, as the technology proves itself and the costs come down, it may well become practical to apply it in the Toronto situation. This is most likely to occur if other functions can share the cost of the required monitoring and communications systems. Examples include automatic meter reading (electricity, gas and water), distribution system load monitoring, load data acquisition for planning, the monitoring of smoke, fire and burglar alarms, cost-of-service analyses, and time-of-use rate structures.

The utilities have done several studies and pilot projects to investigate the practicability of such load management systems. Although the purchase and implementation of a system is not currently being considered, this is certainly an area deserving ongoing study by Toronto Hydro.

More widespread use of peak load management by customers may also be beneficial in reducing system peaks. This will be heavily influenced by future rate structures.

5.7 Time-of-Use Hydro Rate Structures

Time-of-use pricing for electricity could affect all users and theoretically reduce peak demand by raising rates for periods when the electrical load is expected to peak. The argument is that since it is peak use which creates the need for new equipment, it is reasonable to charge customers more for the electricity they use during peak periods. If the peak/off-peak price difference is large enough, customers will increasingly switch to off-peak use, and fewer new supply facilities will be needed.

The (technically) easy first step to time-of-use pricing involves rate differentiation by season. This was recommended for immediate application by the Royal Commission on Electric Power Planning five years ago, and is now planned for large Ontario Hydro customers. The second step, rate differentiation by time of day, would require monitoring equipment that is not in place today.

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The application of time-of-use rate structures in other cities has had mixed results. Ontario Hydro is now experimenting with various time-of-use rates with residential customers. The results of these and other experiments should be carefully monitored for their applicability to the Toronto situation.

Another change to the rate structure which may have an impact on peak demand in the City is Ontario Hydro's proposal to place more weight on the energy charge (total amount of energy consumed) and less weight on the demand (peak use) charge. The impact of these charges will depend on the way in which Toronto Hydro passes them through to its customers.

5.8 Customer Generation of Electric Power

Customer generation means customers generating electricity themselves, to meet all or some of their own needs (self-generation), and possibly also to feed back into Toronto Hydro's distribution network (parallel generation). Ideally this power is produced as a by-product of the customer's other heat-producing activities, through a process known as co-generation.

As far as the JEEP Committee is aware, Redpath Sugar has the only co-generation system operating in the City of Toronto today, although at least one other commercial project apparently investigated co-generation and found that it would be economical, but eventually decided not to proceed.

There is no parallel generation in Toronto. In the United States federal law now requires utilities to buy power produced by outside sources at the "full avoided cost" of producing a comparable amount of power themselves. As a result, customer co-generation already accounts for 2% of total electrical capacity in the U.S.A. and is expected to grow substantially over the rest of this century. Energy Probe has suggested that the lack of any comparable law in Ontario is the main obstacle to parallel generation here. Ontario Hydro delivers power at an average cost which includes inexpensive hydro-electricity - not at the marginal cost of new nuclear-generated power. This leads to what Energy Probe considers to be unreasonably low buy-back rates, which are in fact even lower than Hydro's average delivery costs, for parallel generation, and is also a disincentive to self-generation.

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Self-generation in Toronto is not uncommon. The major hospitals and many large commercial customers have standby generators, usually of limited capacity, for emergency power. Otherwise, all electricity comes via the Ontario Hydro/Toronto Hydro system.

Ontario Hydro's staff have suggested various factors which make co-generation unattractive. They point out that under the present pricing policies the over-riding consideration for would-be co-generators is the need for a balance between electrical generation and heat usage, to ensure high efficiency from the co-generation cycle; anything less, and the system will be uneconomic. They cite three reasons for developers not opting for small scale co-generation applications:

- a lack of trained personnel;
- a marginal improvement in their cost of electricity after consideration of capital cost, fuel, operation and maintenance costs; and,
- the location of the diesel or gas turbine within the building must be carefully selected to ensure isolation and exhaust silencing when it is running.

They cite two other concerns:

- full standby electrical service is usually required in case the co-generation unit fails, and this is expensive for the utility; and,
- downtown locations may not be appropriate for the location of such generators because of the low level air pollution emissions, unless the generators use only clean fuels such as natural gas.

These last points are of particular concern to the City. Because of the need for standby service, co-generation will only impact on the utilities' supply problems when a number of applications are in place within a district. The cumulative effects of any emissions could therefore become a cause of concern.

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Customer-generation is therefore an option that is unlikely to have a big impact on peak period electrical demand. It should be encouraged if gas or another clean fuel is used, but will only reduce Toronto Hydro's facility needs if adopted by several customers in a local area.

5.9 Grants and Loans as Incentives

Financial incentives to either retrofit existing buildings or include energy conservation concerns in new building design have not been explored much for the commercial sector. Unlike the residential market, commercial building owners often have sufficiently high consumption levels that significant cost savings can be realized based on the present rate structure in a relatively short time. According to Ontario Ministry of Energy staff, the forum of large energy users in downtown Toronto have not found a need for any outside help either through loans or grants in realizing considerable operational savings. What has been important to them has been the catalyst role that the Ministry has played as well as the technical advice the Ministry has provided.

Notwithstanding this conclusion, the matter of financial incentives is one deserving further study. Ministry of Energy initiatives have been directed mainly at the largest buildings in downtown Toronto; in the numerous mid-sized and small office buildings, it is the JEEP Committee's impression that comparatively little energy reduction has been achieved. There may be opportunities for a catalytic role that addresses the triple-net lease problem described in Section 3.10. In any event, there is a real possibility that money spent on incentives to reduce peak demand could have an equivalent or bigger impact than the same money spent on new supply and distribution facilities.

The Canada Energy Audit Program (CEAP) provides Federal money for industrial, commercial and institutional building owners to contract an audit and have a consultant design a conservation program (provincial and municipal buildings do not qualify). To date, most of the grants have gone to the industrial sector. The JEEP member agencies, in their dealings with building owners, should promote this program. Grants are provided to assist in the design of a conservation plan. The grant will cover consultant costs to a maximum of $50,000.

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5.10 Encouraging Energy Conservation

Both Toronto Hydro and the City of Toronto are actively engaged in outreach efforts aimed at encouraging energy conservation.

Toronto Hydro's Energy Conservation Section provides an 'energy audit' service to residential, commercial and industrial customers. Staff do site visits and advise customers on measures that can reduce their energy consumption, and what the likely pay-back period is on each such measure. The Section also staffs an Energy Saver Hotline, and participates regularly in conservation exhibits, public lectures, etc. Toronto Hydro has actively advertized and promoted these services.

Since efficient fuel use is at least as important as the type of fuel selected, the JEEP Committee believes that a building energy audit should ideally precede any conversion to electric heat. Toronto Hydro should explore the idea of mandatory audits in all cases where a customer requests a service upgrade in order to convert to electric heat.

The City of Toronto, following its successful Riverdale-area ECCO (Energy Conservation Community Outreach) program, has established several ongoing initiatives:

- Energy Renovation Advice is a service whereby building permit applicants can get expert advice from trained Buildings and Inspections staff on how to incorporate energy-saving measures in their homes or businesses;

- a large percentage of Buildings and Inspections staff are receiving training in energy conservation techniques, so they can offer advice to people in the course of their day-to-day work;

- through Draftstop, a program funded under NEED/CO-ED, the City has worked directly to improve the energy efficiency of people's homes (in cases where the owner's income is below a certain threshold and he or she is elderly, disabled, or a single parent).

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The City also has a program aimed at reducing energy consumption in new buildings, especially large ones in the downtown area. It has published a promotional booklet on Design Guidelines for Energy Efficient Large Scale Buildings, and encourages developers to contact an expert on the City's Plannng and Development staff for further advice. This year, it is planned to make available a computer program which can estimate a new building's energy consumption early in the design stage. (This, like several of the City's programs mentioned above, is receiving funding support from the Ontario Ministry of Energy).

In its planning for the Railway Lands area, the City is looking closely at the possibilities for energy conservation. Detailed design guidelines and policies oriented to this specific area will be developed and implemented by the Planning and Development Department, while the possibilities of district heating and cooling are under investigation by the Department of Public Works.

All of these programs, as well as the outreach and incentive programs of the provincial and federal governments, have contributed to the slower rate of growth in electrical demand and will continue to do so. The impact of such programs on Toronto's future electrical supply needs will depend on their continued existence and promotion, on the extent to which they reduce consumption of electricity (rather than other forms of energy), and on the extent to which they can be designed specifically to reduce peak period demand.

5.11 Conclusion: A Limited Impact

This Chapter began by asking whether the need for new electrical supply capacities could be eliminated or deferred. The JEEP Committee has briefly reviewed a wide range of possible measures and concluded that their impact is likely to be very limited.

The Committee has serious reservations about energy budgets, mandatory district heating, and customer surcharges. Other policies are more promising, but this is a qualified conclusion:

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- load management is already being used in a limited way by Toronto Hydro; new technologies will allow more comprehensive load management, but this will likely have little impact on downtown peak demand;

- peak load control systems are being installed by an increasing number of commercial/industrial customers and apartment buildings; this is being encouraged by the utilities, and is helping to reduce somewhat peak electrical demand;

- time-of-use rate structures deserve further study, but they too are unlikely to significantly change peak demand in the office sector;

- customer-generation has proved unattractive to users in Toronto to date, should be restricted to clean fuels for air pollution reasons, and will only impact on Toronto Hydro's facility needs if adopted by several customers in a local area;

- grants and loans deserve further study, but it is unlikely that their impact would be large;

- energy conservation is already being actively encouraged, and its impact is reflected in JEEP's projections; only new, aggressive conservation programs with an impact on peak-period electrical demand will significantly reduce the need for supply capacity increases.

Despite these negative-sounding conclusions, the JEEP Committee is of the opinion that, collectively, the above measures could result in the short-term deferral of certain capacity increases. Wherever they are cost justifiable, such measures should be pursued.

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6.0 CONCLUSIONS

From the work described in the body of this report, the JEEP Committee has reached conclusions on forecasting, projected electrical load, system impacts and facility needs, alternatives to new facilities, and the need for an ongoing planning and review process.

6.1 On Forecasting Procedures

- It was not practical for the JEEP Committee to apply a computer simulation model to produce scenarios of future land use change and related electrical demand. A complex and sophisticated model would have been needed to produce meaningful results. The cost to develop or acquire such a model would have been high, and much of the required input data is unavailable.
- Detailed data on development proposals is not available beyond a 3-5 year time frame. Load forecasts beyond this period must be based on projections of observed trends and assumptions about future conditions.
- The load forecast methodology developed by Toronto Hydro is the best way now available to produce plausible forecasts of electrical demand in various parts of the City, and for the City as a whole. This methodology has been refined during the course of the JEEP study. One such refinement involves the City's Planning and Development Department regularly providing Toronto Hydro with information on new development proposals.
- Future refinements to Toronto Hydro's load forecast methodology can make it even more effective. In particular, work should continue on:
    - an improved procedure for establishing growth rates;
    - reconciling actual and predicted loads;
    - developing a load-weather model;
    - analyzing build-up and diversity;
    - monitoring electric heat conversions;
    - improving the match between City and Toronto Hydro data bases; and
    - investigating commercially-available land use/load forecasting models.

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6.2 On Projected Electrical Load Growth

- Overall summer peak electrical demand in the City of Toronto is expected to increase from 1511 MVA in 1983 to 2412 MVA in 2000, while winter peak demand will grow from 1509 to 2581 MVA over the same period. This implies summer growth rates slightly above those of the recent past; winter growth rates, because of the electric heating factor, will be about mid-way between those of the recent past and the much higher rates of the early seventies;

- The above projections are based on a continuation of present trends; thus the forecasts take account of the effect of conservation measures. The winter forecast also takes account of predicted conversions to electric heat.

- The JEEP Committee's forecast does not allow for any major increase in conservation measures, or for electricity marketing programs, such as the current GO-Electric campaign.

- This forecast represents the current best estimate of the JEEP Committee, but there is considerable uncertainty surrounding many of its underlying assumptions.

6.3 On the System Impacts of Projected Electrical Load Growth

- Summer is the critical period for most transformer stations and transmission circuits. Summer peak loads in many districts are higher than winter peaks, and the capability of the supply facilities decreases significantly as the temperature increases.

- The forecast electrical demand to the year 2000 will exceed the existing firm capacity;
    - of the existing 230-115 kV transformation at Manby TS and Leaside TS;
    - of the 115 kV transmission systems from these stations into the City; and
    - at almost all of the 13.8 kV transformer stations in the City.

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- Additional transmission capacity can be provided by installing some more underground cables and by modifying existing circuits with no significant adverse impact on neighbourhoods. Similarly, it appears that the additional transformer station capacity which will be needed can be installed at existing station sites without any significant adverse impact on the adjacent neighbourhoods.

- Adding capacity at existing stations is the preferred alternative, other considerations being equal. However, it is possible that one new transformer station may be required in the 1990s in south-central Toronto.

- Impact of the new station in south-central Toronto, if required, would likely be reduced if the station could be located in the Railway Lands. Both the need and the preferred location will depend on the rate and nature of development in the south-central area (including the Railway Lands). However, the option of a site on publicly-owned lands in the Railway Lands should be protected.

6.4 On Alternatives to New Facilities

- Strategies such as load management, time-of-use rate structures, grants and loans, and programs to promote energy conservation may have a limited impact on peak electrical demand and result in the short term deferral of new facility needs. Wherever they are cost-justifiable, such strategies should be pursued. Specifically, Toronto Hydro is encouraged to continue and expand its load management activities, and both the City and Toronto Hydro are encouraged to continue their programs promoting energy conservation in general and energy-conscious design of new buildings in particular; the Railway Lands area appears to offer particular opportunities in this regard.

- Customer-generation has proved unattractive to Toronto customers, should be restricted to clean fuels for air pollution reasons, and will only impact on Toronto Hydro's facility needs if adopted by several customers in a local area.

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- Imposed measures such as requiring energy budgets, making district heating mandatory and adding customer surcharges should not be pursued.

- Toronto Hydro should explore mandatory energy audits in cases where a customer requests a service upgrade in order to convert to some form of electric heating.

- It was beyond the mandate and resources of JEEP to carry out a full cost/benefit study of load abatement measures which would defer or eliminate the need for new electrical supply; however, such a study would likely yield useful results.

6.5 On the Need for Ongoing Review

- There is a large amount of uncertainty associated with ten to twenty year estimates of electricity demand. The Domed Stadium, Railway Lands and Waterfront development, and GO-ALRT Transit System are specific examples of probable new loads with uncertain timing that will have significant impacts on the electricity supply system. Electric heat conversions, energy conservation, and office and industry automation are also contributing to changes in demand. To be prepared to meet electricity demands as they develop, it is necessary to continually monitor the variables affecting future demand and revise the load forecasts accordingly.

- As technology evolves so does the range of viable options for suppressing peak loads or otherwise reducing the need for new facilities. It is important to review such options and their impact on a periodic basis.

- Forecasts of electrical demand are sensitive to changes in various factors including current and forecast economic conditions and the nature of the City's development plans. Areas of the City which may require new transformer stations within ten to fifteen years should be reviewed thoroughly at least every two years.

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- If electricity consumption starts to increase at a more rapid rate, additional City transformer stations may be needed early in the next century. When growth seemed to be accelerating in the early 1970's, new stations in the Yonge/St. Clair, Carlton/Jarvis, and Parkdale (Queen/Roncesvalles) areas were seriously contemplated by the utilities.

- The JEEP Study has proved valuable in educating each of the member agencies about the concerns of the others in relation to planning for electrical facilities.

- There should be continued regular consultation between the City of Toronto, Toronto Hydro and Ontario Hydro on future requirements for electrical supply.

- Additions to Ontario Hydro supply facilities in the City of Toronto are subject to The Environmental Assessment Act 1975 or to The Planning Act 1983 if exempt under The EA Act. An ongoing consultation process would not replace the requirements for public consultation under these Acts.

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7.0 RECOMMENDATIONS

1. That the City of Toronto, Toronto Hydro and Ontario Hydro jointly establish an ongoing Electrical Supply Committee whose meetings should be open to the public. This Committee should meet annually, or more often if circumstances require, to examine and if necessary report on:

   - the current Toronto Hydro load forecasts for the City as a whole and for individual stations and buses;
   - the utilities' current plans, proposals and alternatives for changes to major facilities and their impact on neighbourhoods, with particular attention to any which may require early action;
   - current development proposals and emerging City land use plans and strategies which may affect the future demand for electricity;
   - available measures and techniques which may provide an alternative to supply facility improvements, or allow them to be significantly deferred.

2. That the City of Toronto, with assistance by Toronto Hydro and Ontario Hydro as required, ensure that a site in the Railway Lands suitable for a new transformer station is reserved - unless and until the three parties concur that it is no longer necessary or appropriate.

3. That Toronto Hydro continue to refine its load forecasting methodology, as outlined in Section 6.1 of this report.

4. That Toronto Hydro and the City of Toronto continue to exchange information on development proposals, and work to ensure an adequate matching of data bases by the end of 1985.

5. That Toronto Hydro, Ontario Hydro and the City of Toronto continue and expand their programs to encourage energy conservation in general and energy-conscious design of new buildings in particular, including promotion of the federal C.E.A. Program.

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6. That the City of Toronto continue to explore ways of ensuring energy efficient development in the Railway Lands area.

7. That Toronto Hydro continue and, where it can be shown to be cost-effective, expand its load management activities.

8. That Toronto Hydro and Ontario Hydro continue their investigation of time-of-use rate structures and assess the impact of such structures on the need for expanded supply facilities in the City of Toronto.

9. That Toronto Hydro explore the use of mandatory energy audits in cases where a customer requests a service upgrade in order to convert to some form of electric heating.

10. That the results of recommendations 4-9 be reported to the Electrical Supply Committee.

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GLOSSARY OF TERMS

Alternating Current - current that reverses its direction of flow at regularly recurring intervals of time.

Ampere, Amp - a unit of measurement for the flow of electrical current.

Area Load Growth Rate - a measure of load growth that includes all new load additions.

Autotransformer - a power transformer with a single main winding per phase with both primary and secondary connections made to the single winding.

Bank Secondary Cables - the 13.8 kV circuits between the 115-13.8 kV transformers and 13.8 kV switchgear.

Base Load Growth Rate - a measure of load growth that includes new load additions below 200 kVA.

Blackout - a power supply situation where available generation is not sufficient to supply the demand and customer load is interrupted either intentionally or automatically.

B.t.u. - British Thermal Unit - unit of energy, equal to 0.00029329 kilowatt-hours.

Bus - a conductor or an assembly of conductors for collecting electric currents and distributing them to outgoing feeders.

Buy Back Rate - price paid by the electric utility for electricity generated by the customer.

Capacity - the numerical measure used to indicate the extent to which a component of a power system can fulfil its function. For example, a generator has a certain capacity measured in Megawatts to produce power, another capacity measured in Megawatthours or average MW to produce energy, etc.

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Circuit - a set of conductors, insulated from each other, three for a three phase system, two for a single phase system, through which electric current is intended to flow. All the conductors of each circuit are generally controlled by circuit breakers or switches.

Circuit Breaker - a heavy duty switch which is used to switch circuits or other power system elements in or out of service and which is capable of being automatically opened to separate faulted elements from the system.

Coincidence Factor - is the ratio of the maximum demand of a group of customers or loads to the arithmetic sum of the maximum demands of the individual customers or loads.

Component - one of the many parts of a power system, e.g. a generating unit, a transmission line, a circuit breaker, etc., and also one of the many items of equipment associated with each part, e.g. conductors, insulators, relays, etc.

Co-generation - simultaneous production of heat and mechanical power from the same fuel input. The mechanical power is usually used to drive an electric generator to produce electricity.

Conservation - process of reducing energy requirements.

Customer Generation - electricity generated by a customer.

Core Area - are bounded approximately by Jarvis St., Toronto Bay, Simcoe St., Queens Park/Avenue Rd and Rosedale Valley Road

Cycle - the periodic variation of an alternating voltage or current to reach a maximum from a zero value, reverse and reach a maximum reverse value, and then return to a zero value. On a 60 hertz system one cycle takes 1/60 of a second.

Demand Density, Load Density - a measure of the concentration of load usually expressed in watts per square meter or watts per square foot.

Demand - see Energy Demand.

Direct Current - current which, under normal conditions, continues to flow in one direction only.

DESN - Dual-Element Spot-Network - an arrangement of 115 kV transmission circuits and 115-13.8 kV transformers in which the circuits and transformers are installed in pairs.

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Distribution Facilities, Distribution Network, Distribution System - the facilities used for transmitting energy from the subtransmission facilities (distributing station), or directly from the transmission facilities (regional supply station) where no subtransmission facilities exist, to the ultimate users of energy. They include local distribution lines and transformers reducing the distribution voltage to the level at the customers entrance.

Diversity - the difference between the coincident peak load for a group of customers and the sum of the non-coincident peak loads of the individual customers.

Diversity Factor - the ratio of the sum of the non-coincident peak loads of a group of customers to the coincident peak load for that group of customers.

Electric Energy - the energy associated with the product of voltage and current over an interval of time. It is measured in kilowatt-hours.

Electricity - a term used for the electric current flowing in a circuit.

Energy - this is the ability of a system of components to do work. It is equal to the average power that the system can sustain over an interval multiplied by the time duration of the interval.

Energy Demand - the average power required to supply the load over a stated interval of time.

Energy Load - is energy measured at the point of delivery.

Environmental Assessment (EA) - process of evaluating the impact of proposed projects on the environment.

Fault - a failure of insulation on a power system component which results in extremely high current flow and very low voltage.

Feeders - the subtransmission lines or local distribution lines forming the main stream for the flow of energy.

Forecasting Model - a mathematical relationship or set of relationships used in forecasting.

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Frequency - the number of occurrences of an event in a given period. For alternating current, the frequency is given in cycles per second, more commonly expressed as hertz, Hz.

Heat Pumps - an apparatus for heating or cooling a building by transferring heat by mechanical means from or to a reservoir (such as the ground, water, or air) outside the building.

Interruption - the failure of the power supply to a load.

Kilovolt (kV), Kilowatt (kW), Kilowatthour (kWH) - kilo is the prefix attached to volts, watts or watthours indicating the quantity or magnitude in units of a thousand.

Limited Time Rating (LTR) - the peak load that can be carried by a DESN unit for a specified duration.

Load, Electrical Load - the power delivered to a device; also, the amount of power or energy consumed by customers.

Load Build Up - the gradual increase in a new customer's demand as more load is utilized.

Load Management - collection of techniques for changing electrical loads and the way they impact on the distribution system.

Load Re-arrangement, Load Shifting - the physical rearrangement and transfer of load between supply points.

Load Shedding - the intentional act of cutting off the supply to customers' loads - usually to prevent damaging overloads.

Low Voltage System - the distribution facilities used to deliver power from the 115-13.8 kV transformer stations to the customers.

Megawatt (MW), Megawatthour (MWH) - Mega is the prefix attached to watts or watthours indicating the quantity or magnitude in units of a million.

MVA - Megavolt amp - unit of electrical power.

Network - the term used to describe a bulk power electrical system and the transmission lines which connect the system generators and loads together.

Need/Co-ed - New Employment Expansion and Development/Canada-Ontario Employment Development - a joint federal and provincial venture program for job creation.

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Overload - situation in which the energy demand exceeds the rating of the electrical equipment.

Outage - an outage occurs when a system element is separated from the system as a result of a fault or other cause. An outage may not necessarily result in an interruption to load.

Parallel Generation - the electrical interconnection of two or more independent generating systems.

Peak Load - the highest average load during a time interval of specified duration, e.g., 20 minutes, occurring during a given period of time, e.g., in a day.

Plenum Heaters - one or more heating coils inserted in the hot air plenum or ducts of an existing forced air heating system.

Power - the rate of doing work, or in an electrical network the rate at which electrical energy is being supplied. Sometimes the word is used in a general sense, to cover both power and energy.

Railway Lands - area bounded by Bathurst St., Front St., Lakeshore Blvd. and Yonge St.

Self Generation - electricity generation by a customer.

Single Contingency Loss or Outage - the forced outage of a single system element either automatically or manually.

Spot Network - an electrical grid or interconnection of secondary circuits that is usually localized to the transformer vault in which the transformers are located.

Standard Deviation - a measure of the dispersion of a frequency distribution.

Station - this is a concentration of electric equipment provided to operate and fulfil a specific function on the electric power supply system. As used in this report, it normally means a transformer station (TS).

Substation - same as a station but often used to refer to Toronto Hydro's 4 kV transformer stations and customers' transformation facilities.

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Supply System - the transmission facilities used to connect the generation and the load.

Switchgear - the electrical equipment between the transformer bank secondary cables and distribution feeders.

Switching Station - a station whose function is to interconnect transmission lines through circuit breakers. Its purpose is to subdivide the transmission system to limit the amount of it that is lost as the result of a fault.

System Peak - the highest average load supplied by Toronto Hydro during a time interval of specified duration.

Terminal Station - usually refers to Ontario Hydro's 230-115 kV transformer stations.

Time of use Pricing - prices for electricity that vary with the time of day or season of the year.

Transformer - a device consisting of two or more windings of insulated electric conductors on an iron core for transferring energy from one voltage level to another.

Transformer Station (TS) - a group of electrical components to transfer energy between a set of system components operating at one voltage to another set of system components operating at a different voltage.

Transmission Facilities or System - the facilities used for transmitting energy from the generating stations to the subtransmission facilities, or to distribution facilities where no subtransmission facilities exist. They comprise the bulk power transmission network and the regional supply facilities and include transmission lines, switching and transformer stations.

Transmission Line - the facilities, overhead or underground, usually at voltages of 115 kV and above, for transporting large blocks of electric power from generating stations to load distribution centres and to provide connections between load centres and interconnections with neighbouring utilities.

Triple Net Lease - a rental building lease in which the burden of utility payments is on the tenant.

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Utilities - utilities in this report refers to Ontario Hydro and Toronto Hydro.

Volt (V) - a unit of electrical pressure which tends to cause the flow of electrical current.

Watt (W) - unit of electrical power; represents the power used when one ampere flows through a circuit with a pressure of one volt.

Volt-Amperes, Volt-Amp, VA - unit of electrical power; comprised of both real and reactive power - used to determine the capacity requirements of electrical system components as opposed to real power (watts) which is used for billing purposes. Watts and volt-amps are related by a quantity called the power factor in the following relationship: watts = (volt-amps)x(power factor). The Toronto Hydro power factor at the system level is typically around 0.9.

APPENDIX A

JOINT ELECTRICAL ENERGY PLANNING STUDY

TERMS OF REFERENCE

1. Name

The study shall be called the Joint Electrical Energy Planning (JEEP) Study and shall be administered by the Joint Electrical Energy Planning (JEEP) Group.

2. Purpose and Scope

The purpose of the Joint Electrical Energy Planning Study shall be twofold:

(a) to undertake a comprehensive study to determine electricity demands for the City of Toronto in the medium term (5-10 years) and long term (10-20 years) and to recommend the most appropriate means to augment the existing bulk level system capacity (115 kV plus) to meet the projected demand;

(b) to develop a framework for continued collaboration on the question of electricity planning for the City of Toronto.

In carrying out this work, all parties to the Study recognize the legislated mandate of Toronto Hydro to plan the supply of electrical energy for the City of Toronto.

3. Composition

(a) Members: Representatives to be appointed by Ontario Hydro, Toronto Hydro, Planning and Development Department and the Public Works Department.

(b) Support Staff: Staff of Ontario Hydro, Toronto Hydro and the Planning and Development Department and the Public Works Department shall provide resources to the JEEP Group as necessary.

(c) Chairman: A chairman shall be elected from within the Group.

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(d) Public Involvement: All JEEP Group meetings shall be open to the public (except for discussion of matters directly affecting possible real estate purchases) and interested resident or ratepayer groups shall be notified of these meetings.

4. Responsibilities of the Group

(a) Make use of appropriate computer simulation models in order to project a number of scenarios for future development and land use change in the study area and allow for estimates of electrical demand based on:

(i) the rate of new development;
(ii) the location of new development;
(iii) type of uses (occupancy characteristics); and
(iv) changing patterns of electrical consumption.

(b) Develop a series of strategies for responding to each of the various scenarios for electrical system demand. In developing alternative strategies for these scenarios, the JEEP Group should examine at least the following criteria:

(i) system effects,
(ii) reliability,
(iii) technical feasibility,
(iv) lead time and staging,
(v) initial and long term costs including power loss, operation and maintenance as well as capital costs,
(vi) physical and social impact of alternative strategies, and
(vii) location of any proposed new facilities or expansion of existing facilities in relation to the location of growth in demand.

(c) Develop a preferred plan or plans to provide a phased program to match possible future requirements within the City.

(d) Establish a monitoring system which will enable the identification over time of the most likely development scenario and, where appropriate, make modifications to the preferred plan or plans based on the degree of correspondence between actual development and simulated development scenarios.

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5. Reporting

(a) The JEEP Group shall prepare reports from time to time for concurrent submission to the Toronto Hydro Commissioners, Ontario Hydro and to the City Services Committee for onward transmittal to City Council, reviewing the progress of the study.

(b) The JEEP Group shall prepare a final report setting out the preferred plan or plans with recommendations for concurrent consideration by City Council through its City Services Committee, Ontario Hydro and the Toronto Hydro Electric Commission. Action of this report would rest with the Toronto Electric Commissioners. In the event that such plans include the establishment of a station on a new site, this report and the JEEP Study leading to the report would form the starting point for an environmental assessment.

6. Time Frame

The JEEP Group shall conclude its deliberations and prepare its final report within two years of initiating the JEEP Study.

APPENDIX B

SEMINAR ON LOAD CHANGES IN THE COMMERCIAL OFFICE SECTOR

JOINT ELECTRICAL ENERGY PLANNING STUDY, NOVEMBER 23, 1983

In Attendance

John Brooks, Toronto Hydro
Rob Lister, Toronto Hydro
Bern Brenner, Toronto Hydro
Ted Mackay, Ontario Hydro
Martin Bain, Ontario Hydro
Don Batty, Public Works Department
Barbara Leonhardt, Planning and Development Department
Simon Chamberlain, Planning and Development Department
Tom Ostler, Planning and Development Development

Panelists

Tom Tamblyn, Engineering Interface
Lorne Mitchell, TMP Consultants
Bruce Robertson, Petrosave Inc.

Interested Parties

Norm Rubin, Energy Probe
Helen Edwards
Christine Silvester, Ontario Hydro Load Forecast Department
Jim Heller, Ontario Hydro Load Forecast Department
Alex Telegdi, Planning and Development Department
Nancy Singer, Planning and Development Department

Introduction

Simon Chamberlain outlined the background of the JEEP study, and the Group's interest in this particular area given the difficulty encountered in forecasting demand for the downtown area. The following is a synopsis of the commentary offered by the panelists and others pertaining to the outline given to the panelists.

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1. The Decision-making Process

Q. Demand patterns are related to decisions made early in the design and construction phases of major projects.

- Who are the decision makers?
- To what extent do key design decisions take account of energy conservation (see the report: Energy Efficient Large Scale Buildings - Design Guidelines)?
- What are the key factors in evaluating alternative energy sources for a new building (e.g. long term savings versus the risk involved in being a test case for new technology)?

Almost all new large buildings over 20,000 square metres are developed with the advice of a design team of architects and engineers who gather information and make recommendations. There can be conflicts between architects and engineers; however, the mechanical engineers are usually brought into this team setting after the proponent and his architects have decided on such things as height, bulk and typical floor area size.

This team considers both capital costs and operating costs of all special features, but capital costs are crucial for the developer. Some designs may be subjected to a computer-modelling exercise to determine heat loss and other characteristics. While cost is the most important factor in evaluating conservation measures, other factors often come into play since there is a possibility of the chosen action affecting other decisions. For example, triple glazed windows reduce heat loss to the extent that the mechanical system distribution can be centrally located rather than running under the windows.

The design approach is generally more innovative in the case of larger buildings. For small buildings (10-20,000 square metres) the decision process is more basic, with more use of "off the shelf" techniques and the engineers often called in later in the process.

A very important factor influencing the energy decisions, both in new and in existing buildings, is the type of ownership. Owner-occupants seem to be more interested in taking advantage of conservation initiatives. Rental buildings pose a dilemma in that the prevailing type of lease, "triple net lease", places the burden of utility payments on the tenants, who have no ready mechanism for acting collectively.

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2. The Experience To Date

Q. There has been some progress in terms of refining the traditional decision-making process in some projects. From an energy efficiency standpoint there are a number of "generations" of commercial buildings downtown right now.

- What are the prime factors leading toward changes to the decision-making process or to changing attitudes on the part of traditional decision makers? (e.g. Are owner-occupant corporations more energy conscious than speculative developers?)
- What savings have been achieved through energy management systems and the retrofitting of older buildings downtown? In particular, what have the effects been on peak demand?

Many designs claim to be energy efficient, but little reconciliation is attempted after the building is occupied. To term a design "efficient" does not mean that it will operate efficiently. Some mechanical engineering firms are getting into contracts where they participate not only in the design phase but in the "commissioning" or initial operation of the physical plant as well.

In 1972 Hydro Place was a state-of-the-art design. Participants were on the leading edge of a learning curve in this field. Today the learning curve has pretty well flattened out. Regardless of which measures developers/owners opt for in a new building, or in retrofit, the majority of the knowledge needed is available to most engineers. In terms of 'watts-per-square foot", the design load has come down from about four watts per square foot to two watts per square foot for lighting and appliance use since 1973. The building envelope used to have a fair amount of glazing and was very leaky. Now all commercial buildings are at least double glazed, if not triple, and the area of glazing has been reduced significantly. Also, boiler plants have been pretty well halved in size with the more recent movement to building "tighter" buildings (less air leakage). There is a real awareness now on the part of design teams to make the curtain wall airtight.

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Capital investors have become aware of conservation measures to the extent that their application affects the rate of return on investment. Payback periods of individual measures are not considered per se but as a rate of return affecting cash flow. This is particularly true for older buildings. Most owners have done something to improve their energy budgets as a means of reducing operating costs. A speculative owner would ideally like to realize a payback in two years. There was general agreement that as total energy consumption has dropped, electricity has taken a relatively larger share.

3. What Does the Future Hold?

Q. - What savings potential remains to be realized downtown through better management and/or retrofitting of buildings not already upgraded?

- Will energy savings in heating/cooling be offset by increases in demand due to changing working conditions (e.g. the electronic office work station)?

- What opinions can you offer on future advancements in the area of building design, construction and management from the standpoint of energy efficiency, including anticipated advances in retrofit technology and such innovations as gas turbine co-generation?

An important consideration is how occupancy will change. New applications and uses of electricity (e.g. computer terminals) have largely made up for the savings experienced to date in the theoretical design load. Perhaps a reasonable assumption is that the current level will be maintained (e.g. Scotia Plaza is being designed for five watts per square foot evenly distributed over the floor area).

There is an untapped conservation potential in existing buildings but it is questionable that it can be realized. For example, in one building only two tenants (out of 20 floors) took advantage of a lease credit scheme for disconnecting lights. The barriers here are access to money, first and foremost, and a related issue for rental apartment buildings has been the rent control legislation.

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4. What are the Implications for Electrical Forecasting?

Q. - Will future savings through retrofit be significant enough to affect growth trends currently used in forecasting?

- How can these future savings be accommodated in Hydro's demand forecast method?

To what extent would supply constraints affect development downtown? Some people feel that such constraints would not really affect the ultimate scale of development, but other design features and the timing may be affected. For the developer's team the supply problem is an "energy" question and there are a number of different ways of getting that energy.

5. Public Sector Influence

Q. - Has the public sector been a help or a hindrance in this area to date?

- Can the public sector (City of Toronto, Toronto Hydro, Ontario Hydro, Province) influence future decisions in favour of reduced energy consumption? If so, how?

Should we use a "carrot" or a "stick" approach? Quebec Hydro is using the carrot approach in subsidizing commercial audits. If you want to reduce demand, recognize that it is in the owner's interest and help him to realize it. Boston and Dallas both have instituted special rate structures for customers with electric thermal storage structures.

If we want to affect peak demand, a significant change in the rate structure might help; building owners might be more inclined toward retrofit measures. On the other hand, since the rate change would affect all buildings equally, it won't really affect the marketability of floor space and therefore may have little effect.

Taking a stick approach is also possible. For example, if the decision were made that no new transformer station would be built downtown, then developers would be forced to examine alternative sources of supply. This is true to the extent that such new projects are not "footloose". For example, in many European cities a new building is allocated a quantity of watts and they have to use it in the most appropriate way.

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A feasibility study of the conservation potential to be realized in the Railway Lands development is an interesting possibility. It could consider the limitations of the power supply as well as new applications like the district steam heat system and the use of water from Lake Ontario in cooling buildings. However, at a practical level, the question arises of whether things would become too complex for the developers to remain interested? In general, the development community prefers simple, proven concepts.

APPENDIX C

JEEP COMMITTEE INTERIM REPORT

CITY OF TORONTO
JOINT ELECTRICAL ENERGY PLANNING COMMITTEE

To: City Services Committee, Toronto Electric Commissioners and Ontario Hydro

Subject: Interim Report, August 18, 1983

Background:

In May 1983 City Council and the Toronto Electric Commissioners approved Terms of Reference for a long run joint study of electric demand in the City (the Joint Electrical Energy Planning Study - JEEP). The need for such a study was originally identified during discussions about the proposed expansion of the Cecil Transformer Station in 1981. At that time the suggested study was concerned with only the Central Area but subsequent discussions led to the conclusions that the entire City should be included. The study group includes representatives from Ontario Hydro, Toronto Hydro and the Public Works and Planning and Development Departments. The purpose of the study is to examine the demand for electricity over the medium (5-10 years) and long term (10-15 years) and to recommend the most appropriate means of augmenting the existing bulk power system to meet the projected demand.

The Committee started meeting in July 1982 and established that forecasting would be undertaken for fairly large districts incorporating groups of transformer and switching stations. The Committee met on a fairly regular basis throughout the fall of 1982 and into the early spring of 1983. The meetings have been open to the public, and Energy Probe has had a representative at every meeting who has often contributed to the discussion. In addition, a number of resident groups and interested individuals have requested to be placed on a mailing list and can contact the Committee Secretary for copies of any material tabled.

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Initiatives of the Committee

Since the Downtown Core has experienced the most rapid growth in electric demand, and could pose problems in the future with significant construction in the Railway Lands and Harbourfront, the Committee focussed attention on this area (the South-Central Service Area).

A forecast had been prepared by staff of Toronto Hydro and Ontario Hydro which concluded that a new transformer station would be required in this area between 1989 and 1995. The JEEP Committee established a load forecast task group with a mandate to review the given forecast and explore forecasting methodology in general.

An attempt was made to determine the degree to which electrical demand is correlated with the construction of new floor area. This was seen as being particularly relevant for the Core Area. While there appears to be some correlation between the rate of growth of office space and overall electrical demand, forecasting is limited by the data available to match floor space with hydro consumption and by the extent to which growth in floor space can be projected. While it is possible for City staff to estimate office space growth in the Core with reasonable accuracy, it is much more difficult to predict medium and long run growth for other land uses, particularly outside the high growth area downtown.

Notwithstanding these limitations, some fairly significant benefits came out of the forecasting attempt:

- As part of the process of preparing a Scope of Study Document required to initiate an Environmental Assessment, a review of the original forecast led Toronto Hydro and Ontario Hydro to conclude that new transformer facilities would not be required in the South-Central area as early as anticipated. The drafting of a Scope of Study Document has therefore been postponed. The primary reason for the deferral was a decision to make use of larger transformers at existing stations if necessary or desirable. Since the downtown core can quickly use up existing spare capacity and advance the requirement for a new transformer station, the situation must be monitored. Toronto Hydro's annual reviews of current and proposed loadings in the South-Central area will allow a timely decision when and if it is necessary to re-institute the study.

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- Since the land use development projection showed that future growth over the long term will be concentrated in the Railway Lands and Harbourfront, Toronto Hydro is exploring the possibility of having a parcel of land set aside within the Railway Lands for a transformer/switching station site if and as required.

- It was recognized that the database maintained by the Planning and Development Department was of considerable benefit in enhancing the current forecasting data of Toronto Hydro. The resolution of problems encountered in matching records between this database and that of Toronto Hydro will be beneficial to any future forecasting efforts. City and Toronto Hydro staff are currently exploring the possibility of database reconciliation as a basis for future forecasting.

Conclusions

It appears that the JEEP Study has provided a useful forum for exploring new methods of forecasting electrical demand. It has also been a useful forum for the exchange of information and the co-ordination of planning efforts. This inter-agency link has also been of some use in bringing parties together. For example, staff from Ontario Hydro and the Harbourfront Corporation were brought together to discuss the future of Hydro property at 230 Queen's Quay West. Also, Toronto Hydro took advantage of a Committee meeting to explain a new program for replacing overhead wires in residential areas.

Future Work

In the coming months, the JEEP Committee is proposing to:

- continue meeting as a forum for the exchange of information between City and Hydro staff;

- explore anticipated electric power demand and future hydro facility needs in other parts of the City;

- review the newly released study by Toronto Hydro entitled "Toronto Hydro Residential Load Growth"; and

- begin the work of reconciling the City's database with that of Toronto Hydro, as a basis for improved electricity demand forecasting.

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Recommendation:

That this report be received for information.

Simon B. Chamberlain
Chairman

APPENDIX D

THE POWER SUPPLY SYSTEM AND ITS LOADING LIMITATIONS: TECHNICAL DETAILS

Toronto's electric power is supplied from Ontario Hydro's bulk power system through 230-115 kV transformation, located at A. W. Manby TS in Etobicoke and at Leaside TS in East York, via a 115 kV transmission network to fifteen transformer stations where the voltage is reduced to 13.8 kv for distribution to Toronto Hydro's low voltage network. The existing system is shown on Figure 1, while the location of the 115-13.8 kV transformer stations is shown on Map 1 (both found in Chapter 2 of this report). The design and operation of the system are illustrated by Figure 7 and the following description.

The arrangement of 115 kV transmission circuits and 115-13.8 kV transformers is based on the Dual-Element Spot-Network (DESN) design. This design provides transmission circuits and step-down transformers in pairs. The principal characteristics of the DESN supply are as follows:

(a) 115 kV circuits are supplied from a switching station and comprise a pair of overhead transmission circuits or underground cables, or a combination of both.

(b) Each pair of circuits supplies one or more 13.8 kV transformer stations.

(c) Each 13.8 kV transformer station consists of one or more DESN pairs of transformers. Each transformer of a pair is connected to a separate 115 kV supply circuit and its secondary winding is connected to a Toronto Hydro low voltage bus through a transformer circuit breaker.

Large transformers, as installed in most of the Toronto stations, have two secondary windings. A DESN pair of these units have their secondary windings cross connected and supplies two separate low voltage buses. This keeps the secondary currents within available 13.8 kV circuit breaker ratings, and limits short circuit duties on equipment to established levels.

. . . ./D-2

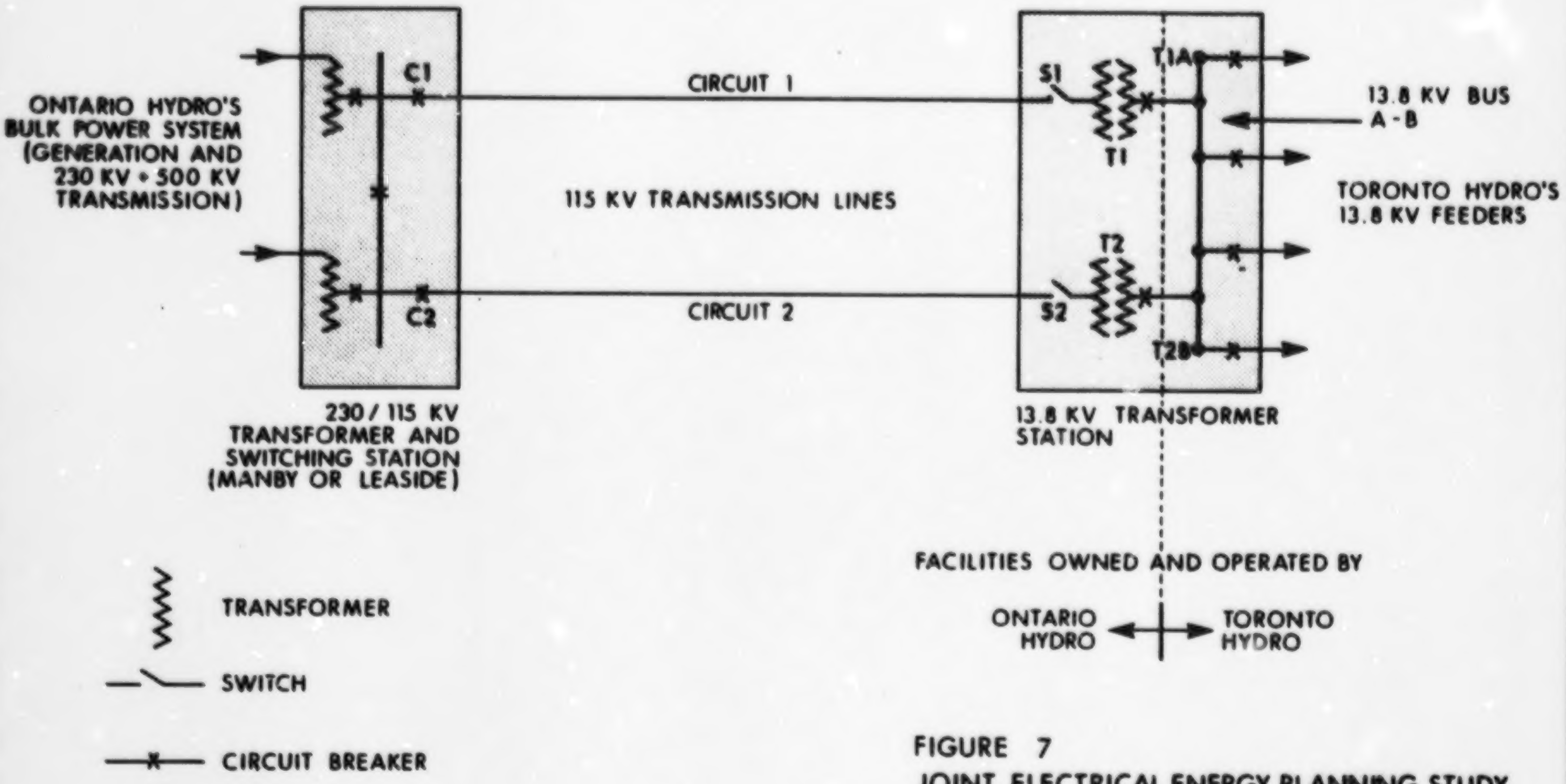
ONTARIO HYDRO'S BULK POWER SYSTEM (GENERATION AND 230 KV + 500 KV TRANSMISSION)
C1
C2
230 / 115 KV TRANSFORMER AND SWITCHING STATION (MANBY OR LEASIDE)
CIRCUIT 1
115 KV TRANSMISSION LINES
CIRCUIT 2
S1
T1
T1A
S2
T2
T2B
13.8 KV TRANSFORMER STATION
13.8 KV BUS A - B
TORONTO HYDRO'S 13.8 KV FEEDERS
TRANSFORMER
SWITCH
CIRCUIT BREAKER
FACILITIES OWNED AND OPERATED BY
ONTARIO HYDRO
TORONTO HYDRO

FIGURE 7

JOINT ELECTRICAL ENERGY PLANNING STUDY

DESIGN AND OPERATION OF ONTARIO HYDRO'S 115 KV SUPPLY SYSTEM

322/02123

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(d) Each transformer has a 115 kV motor-operated disconnect switch or circuit switcher.

(e) Each transformer has a dual self-cooled/forced cooled continuous rating of 100/167% at an ambient temperature of 30°C and is equipped for under load tap changing (ULTC). That is, it has automatic switching facilities that operate while the transformer is loaded, to change the HV/LV winding ratio and maintain the secondary voltage at desired levels.

(f) Under normal operation, with all facilities in service, the load supplied by a DESN pair of circuits and transformers will be shared equally by each element. If a fault develops in one element, the faulted half of the DESN is automatically switched out of service and supply to the LV bus is maintained through the unfaulted half. For example, referring to Figure 7, if a fault developed in transmission circuit 1, protective relaying would operate instantaneously to open the 115 kV circuit breaker C1 at the switching station, and transformer circuit breaker T1A at the DESN station (plus transformer circuit breakers for any other transformers supplied from circuit 1) to isolate the fault. The line breaker C1 would then automatically reclose and if the fault has been cleared, C1 will remain closed and will be followed by the reclosing of breaker T1A to return the supply to normal. If the fault persists, C1 will reopen and stay open to isolate the fault. Supply to the low voltage bus A-B would be maintained via circuit 2 and transformer T2. There would be a voltage dip at the A-B bus immediately following the fault, since the load on circuit 2 and T2 would be twice what it was prior to the fault, resulting in a greater voltage drop through these elements. However, the voltage at bus A-B would be quickly restored by the automatic operation of ULTC equipment on transformer T2.

If a fault occurs on transformer T1, the same switching sequence would isolate circuit 1 and T1. However, the 115 kV transformer switch S1 would be automatically opened to isolate T1 allowing circuit 1 to be returned to service for normal supply to the other DESN units supplied from that circuit.

. . ./D-4

(g) Modifications and variations of the DESN system as described above can be used, such as:

- Small transformers paralleled and operated as one unit;
- A number of 115 kV circuits paralleled through 115 kV circuit breakers. For example, with the existing switching at John TS and Wiltshire TS, the firm transmission capacity to these stations is rated on the basis of 3-out-of-4 circuits being available, rather than two pairs each rated at 1-out-of-2.
- A DESN pair of circuits connected to another DESN pair through normally open switches. With this arrangement, one DESN pair provides backup to the other in the event that both circuits of either pair are taken out of service simultaneously. It also allows load to be transferred from one 230-115 kV transformer station to the other; in the Toronto case, this means that loads can be transferred between Leaside TS and Manby TS.

Loading Limitations of System

The DESN system is normally operated so that when one element is out of service, with only half the system in service, the total loading on the DESN pair will not exceed the permissible emergency rating of the other half. The limitations are set by thermal considerations.

- The limitation for overhead transmission lines is the lesser of the current that will result in a maximum conductor temperature of 150°C or that will cause conductors to sag to the minimum conductor-to-ground clearance permitted by CSA standards.
- The limitation for underground cables is the maximum current that can be carried without exceeding a temperature which will reduce the life of the cable insulation.

. . ./D-5

- The limitation for transformers is the maximum load that can be carried for 10 days under seasonal ambient temperature conditions with a computed loss of transformer life not exceeding 2%. A further condition is that the maximum transformer hot-spot temperature not exceed 150°C, but this condition is seldom limiting. The 10-day period is the estimated number of working days required to replace a permanently faulted transformer.

  This limited time rating (LTR) of a transformer is about 1.6 and 1.3 times its continuous forced-cooled rating for winter and summer ambient temperatures, respectively.

- Circuit breakers and bus connections, etc., have emergency ratings only slightly in excess of their continuous ratings. These facilities, therefore, are rated to match the LTR of series components and thus avoid limiting the DESN supply.

The existing 115-13.8 kV transformers and the limited time ratings of the 13.8 kV buses in the fifteen transformer stations which serve Toronto Hydro are shown in Appendix H.

APPENDIX E

LEGISLATION GOVERNING APPROVAL PROCESS FOR NEW FACILITIES

Ontario Hydro is subject to The Environmental Assessment (EA) Act 1975 as well as other provincial legislation. When an Ontario Hydro or Toronto Hydro undertaking is exempt from the application of The Environmental Assessment Act, it is still subject to the provisions of The Planning Act 1983, including municipal official plans and zoning by-laws.

1.0 ENVIRONMENTAL ASSESSMENT ACT 1975

Different approval processes are available under the EA Act, depending on the nature and extent of the plan (the undertaking) as follows:

1.1 Exempt Plans

New transmission line taps less than 2 km long which operate at 115 kV or higher are exempt from the EA Act on the condition that Ontario Hydro consults with the Ministry of the Environment.

Certain types of undertakings are unconditionally exempt from the EA Act. These include:

- Activities involving facilities which operate at a voltage less than 115 kV.
- Upgrading of existing transmission lines which operate at 115 kV or higher and which require the replacement of angle structures only.
- Modifying or upgrading existing transformer stations which operate at 115 kV or 230 kV and which do not require an enlargement of the site.

. . ./E-2

1.2 Class Environmental Assessment

Certain types of undertakings occur frequently, are relatively small in scale, have environmental effects which are expected to be acceptable and are planned and constructed in accordance with a common process. Environmental assessments for these undertakings are carried out following the Class Environmental Assessment, a procedure which itself was approved under the EA Act. These undertakings include:

1. The planning of, the acquisition of property for and the design and construction of a minor transmission line and/or a minor transformer station and/or a communication tower, and the subsequent operation and maintenance of these facilities.

   Minor transmission lines include all transmission lines longer than 2 km (1.25 mi) which:

   - Are capable of operating at a nominal voltage level no higher than 115 kV;

   - Are capable of operating at a nominal voltage level higher than 115 kV and which are shorter than 8 km (5 mi) more or less.

     Minor transformer stations include those stations whose nominal operating voltage level is not less than 115 kV and not more than 230 kV. (Where a station has more than one voltage level, the highest level is used to determine whether or not the project is covered by this class definition.)

2. The planning, design and construction of a minor transmission line and/or a minor transformer station and/or a communication tower on property previously acquired, and the subsequent operation and maintenance of these facilities. Such property may have been acquired prior to proclamation of The Environmental Assessment Act, 1975 or subsequent to that time but for a different specific use.

. . ./E-3

3. The planning, property acquisition, design and construction required to extend and/or upgrade existing line or station facilities, and the subsequent operation and maintenance of revised facilities, where:

   - In the case of a line, it is capable, after upgrading, of operating at a nominal voltage level of at least 115 kV and the upgrading includes replacement of poles or towers (other than angle poles or towers), and/or a change in the right-of-way.

   - In the case of a station, it is capable of operating at a nominal voltage level not less than 115 kV and not more than 230 kV, and involves an extension of the site to include property not previously owned by Ontario Hydro. (If a station has more than one voltage level, the highest level is used to determine whether or not the project is covered by this class definition.)

Major features of this Class EA process are:

- When a need has been identified, Ontario Hydro must first develop alternative options to supply the need. It must then give initial notification to the potentially affected public, municipal and provincial officials. This notification will state the system need for the proposed project, the alternative options available, the area proposed for study and the rights given to the public under the EA Act.

- A draft document describing the scope of the study is then discussed with the public and the elected and appointed officials and modified, if necessary, to serve as terms of reference for the study.

. . ./E-4

- Public involvement is required throughout the study. This is attained in various ways, depending on the nature and location of the study, and the wishes of the public. In urban areas, it usually involves working committees of individuals from the study area who represent organizations having special concerns or interests and a liaison committee of local officials. The general public are involved through information centres and newsletters to those who have indicated interest.

- Alternative routes and sites to satisfy the options must be identified. They are evaluated taking into account economic, engineering and environmental factors, including public and committee inputs, and the planning policies and zoning by-laws of the municipality. From those that are environmentally acceptable, Ontario Hydro will choose a preferred site or route and issue a final notification describing the selected site or route. This will be by letter to the people initially notified, those directly affected and those who have developed an interest in the project during the study. The general public are also notified through newspaper advertisements.

- If there has been no expressed opposition following Ontario Hydro's final notification, then the selected alternative will be considered acceptable. The project then remains within the class definition and an Environmental report is filed with the MOE and made available to the public. Ontario Hydro may then apply for an Order-in-Council under the Power Corporation Act for property acquisition and/or construction of the facilities.

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1.3 Individual Environmental Assessment

An individual Environmental Assessment must be carried out for any undertaking which does not qualify for an exemption or a Class EA as discussed in 1.1 and 1.2 above, or if there is unresolved expressed opposition at the end of a Class EA process.

This involves the same process as the Class EA up to the assessment of the acceptability of Ontario Hydro's preferred alternative, followed by the submission of an environmental assessment document to the MOE. The Minister of the Environment will then publish a governmental review of the EA and public hearings if requested will be conducted by a Hearing Board under the EA Act or the Consolidated Hearings Act, as appropriate. If the assessment is approved, Ontario Hydro may then apply for an Order-in-Council under the Power Corporation Act as in the case of a Class EA.

1.4 Approval Timing

It is expected that the approval process for most of the future additional supply facilities for the City of Toronto will fall in either the Exempt or Class EA categories. The Class EA process may require about two years to complete. If an Individual Environmental Assessment is required, a total period of up to four years or more may be necessary to obtain approval.

2.0 PLANNING ACT 1983

The Planning Act 1983 provides that Ontario Hydro in exercising any authority that affects any planning matter shall have regard to any policy statements issued by the Government of Ontario. It also provides that before carrying out or authorizing any undertaking that Ontario Hydro considers will directly affect any municipality, Ontario Hydro shall consult with, and have regard for, the established planning policies of the municipality. Subject to this consideration, planned additions to the electric power system, which are approved under the EA Act are not subject to The Planning Act. Those undertakings that are exempt from Class or Individual Environmental Assessment are subject to all the provisions of the Planning Act.

APPENDIX F

LOAD FORECAST METHODOLOGY: DETAILS

(This appendix contains the load forecast guidelines provided by Toronto Hydro to its staff.)

FORECAST FORMAT

The minimum requirements for a load forecast are outlined as follows:

1) Summary
2) Recommendations
3) Load Growth Rates
4) Firm Capacities
5) Load Transfers
6) Assumptions
7) Reconciliations
8) Abbreviations
9) Switchgear Arrangements
10) Tabulations

The above sections are to be presented in the forecasts in the same order as they are listed.

1) SUMMARY

- State the major conclusions of the forecast.
- Refer to Annex 1 for examples.

2) RECOMMENDATIONS

- State your recommendations as to areas that require further study and the in-service dates of capacity increases and load transfers.

- Refer to Annex 2 for examples.

3) LOAD GROWTH RATES

- Base and area growth rates are used to describe the anticipated load growths on each of the buses. The growth rates are determined by analyzing the historic bus peak load data. The base growth rates are calculated by excluding any new loads over 200 kVA. The area growth rates include all new loads regardless of size.

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The base load growth rates should be applied to the first few years of the tabulations. The area growth rates should be used for the remaining years of the forecast. The growth rates should be prorated accordingly as large load transfers occur among buses. Justification for using the lower growth rates for the first few years is based on the assumption that Toronto Hydro is aware of many of the new loads that will occur. The purpose of the base growth rate is to allow for new services less than 200 kVA and for large loads that are not known of at present. Refer to Annex 3 for a sample calculation of base and area growth rates.

In previous forecasts, the transition from base to area growth rates has occurred in the same year for all buses of a station. This procedure often left buses with only 1 or 2% growth per year for three or four years. To alleviate this problem, each bus is to have its own transition year, independent of the growth rates applied on the other buses. Base growth rates should be applied for at least two years. The transition to the area growth rate should then occur in the year that the sum of the proposed services' load in that particular year and the base growth, is less than the area growth.

The peak summer/winter loads on each bus have recently been analyzed in order to determine revised growth rates for use in the forecasts. In many cases the calculated growth rates were unreasonably large or negative. These irrational results can be attributed to the lack of adjustments for the weather influence and the uncertainty of the impact of the load transfers on the bus peak loads. Many of the revised rates are educated guesses of growth, primarily based on growth rates used in previous forecasts and recent trends in loading. The recommended growth rates do not include the electric heating component that we are anticipating in the next decade. Annex 4 contains projected load increases on the 4 kV stations due to electric heat. These projections have been adjusted to reduce the effect of compounding. Refer to Annex 5 for an illustration of the procedure used to adjust the projections.

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Forecasters are not bound to using these revised growth rates and should treat them as recommendations. The type of load on each bus should be analyzed to identify unique characteristics that may affect the growth; eg. there may be little or no base growth on load that is comprised of a few large 13.8 kV customers. Further analysis is encouraged if the forecaster has additional information.

- Refer to Annex 6 for the list of growth rates.
- List the growth rates applied in the tabulations.
- Refer to Annex 7 for examples.

4) FIRM CAPACITIES

- Include a tabulation and/or explanation of the present firm capacities, interim reduced Limited Time Ratings (LTR's) and proposed capacity increases.
- Consult the Station Planning and Design Department for details on proposed capacity increases.
- Refer to Annex 8 for examples.

5) LOAD TRANSFERS

- Explain why previously proposed transfers have been cancelled or rearranged.
- Provide a table identifying the buses involved, the loads, in-service dates, and approximate costs.
- Refer to Annex 9 for an example.

6) ASSUMPTIONS

- List all the major assumptions made in preparing the forecast.
- Refer to Annex 10 for an example.

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7) RECONCILIATIONS

- Ideally, all differences between the load predictions from the previous forecast and the actual peak loads recorded should be reconciled. In many cases however, the differences are not easily explained. The forecasters are required to analyze the loading and if possible, provide a comprehensive explanation of the differences.
- Refer to Annex 11 for examples.

8) ABBREVIATIONS

- Include a list and defnition of all abbreviations used in the forecast.
- Refer to Annex 12 for an example.

9) SWITCHGEAR ARRANGEMENTS

- Include sketches of the present switchgear arrangements.
- To improve clarity, it is recommended (but not required) that proposed switchgear arrangements after major feeder rearrangements also be included.
- Refer to Annex 13 for an example.

10) TABULATIONS

- An interactive computer program has been developed which organizes and tabulates the bus load projections. Forecasters are required to become familiar with this program and use it to prepare the load tabulations.

Emergency and Routine Maintenance Inter-Bus Transfers

On occasion (in an emergency or for routine maintenance), load will be transferred between buses. These transfers are usually documented in the Monthly Peak Load Reports. When determining the peak load for a particular season, the forecaster should verify that there were no unusual operating conditions at the time of the peak.

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Starting Point of Load Projection

Adjusted peak loads are to be used for the starting points of the load projections. The amount of the adjustments from the actual peak loads are to be determined by taking into consideration any factors that would have caused the bus peak loads to be unusually high or low, eg. moderate or extreme weather conditions, emergency or routine maintenance inter-bus transfers. Due to the recent weather conditions, the following adjustments should be made:

Winter 1982/83 - increase actual peak by 5%.

Summer 1983 - apply actual peak.

Proposed Services

Most new services do not reach their full demand until some time after connection. Many services are also developed in phases. It is critical that the forecaster determine the stages of load growth and indicate this load build-up in the tabulations.

It is recommended that the forecaster talk to the service representative and planner for each service and verify or revise the proposed load and timing of the load build-up.

If the service representatives cannot project the timing of the load build-up, apply the following guidelines:

PROPOSED LOAD	FIRST YEAR	SECOND YEAR	THIRD YEAR
< 0.5 MVA	100%		
0.5 to 2 MVA	70%	30%	
> 2 MVA	60%	20%	20%

Diversity and kW to kVA Conversion

The proposed loads on the Project Schedules are in kW units. Ideally, the forecaster should convert the load to kVA using a power factor in the range of 0.8 to 0.95. At the same time, a coincidence factor in the range of 0.7 to 0.95 should be applied to the load to account for the diversity between the customer's peak load and the bus peak load. Due to the lack of detailed information on diversity and power factor, the forecaster should use the projected kW loads from the Project schedules (or the revised loads received from the planner or service representative) and assume that this procedure accounts for kW to kVA conversion and diversity.

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Load Transfers

The load assigned to transfers must be diversified. It is not acceptable to just sum the peak loads of the customers being transferred. The forecaster should attempt to determine the amount of the bus peak load that will be affected.

Maximum Load Growth

In the past, forecasts have often projected load increases in the first few years at annual rates in excess of 15% due to optimistic in-service dates of new customers. An analysis of load growth on 13.8 kV buses has indicated that the annual load growth on any one bus rarely exceeds 10%. To keep the load projections in line with this amount of growth, forecasters should spread out the load of new customers in addition to the staging of load build-up already established. Certainly there are situations in which this procedure is not justified. Forecasters are required to use their judgment when suppressing proposed load development.

Firm Capacities and Reduced LTR's

The firm capacity of a large power transformer is limited by established hot spot and/or insulation aging limits. The actual permissible emergency load depends on the ambient temperature. The summer planning Limited Time Ratings (LTR's) in Toronto are based on an ambient temperature of 31 degrees C. (87.8 degrees F.). The winter planning LTR's are based on an ambient temperature of +5 degrees C. (41 degrees F.).

For an overload, a transformer outage must occur:

- in a year and season when the load is near the transformer's capacity, and
- on a working day when the temperature exceeds 31 (if summer) or 5 (if winter) degrees C., and
- at the time of the peak load for the day

The probability of these events occurring simultaneously is very low.

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The loading arrangements of buses and the decisions to increase capacity are primarily based on the firm capacities received from Ontario Hydro. Under normal weather conditions, this approach should prevent overloads. The LTR's decrease as the ambient temperature increases. If a transformer outage occurs on a day during an unusually extreme hot spell or cold spell, it is quite possible that an overload situation will occur. We are not forecasting or installing capacity to allow for the most extreme weather conditions that may occur. In the event of an overload, Ontario Hydro will drop load.

Ontario Hydro is currently reviewing the LTR's of their transformers. The firm capacities on a number of buses have already been reduced. Interim reduced LTR's have been issued for all bus firm capacities that are under review. The interim reduced LTR's that are below the present operating LTR's are to be used for determining the timing of load transfers and capacity increases. In some cases, the interim reduced LTR's are already exceeded. Ontario Hydro has stated, however, that no costs are to be incurred due to the reduced LTR's until the changes have been verified. For planning and forecasting purposes, exceeded interim reduced LTR's will be accepted until 1985. After 1985, provision should be made to relieve all overloaded buses.

Forecast Time Horizon

The tabulations are to project peak loads for the next ten years. Load transfers to alleviate overloads are only required for the first five years.

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ANNEX 1 - EXAMPLES OF A 'SUMMARY'

Ex.1 Summary

The A4-5 bus has exceeded its firm capacity and all further growth on this bus must be transferred to the A1-2 bus or another source.

The load on the A6-7 bus can be expected to exceed the bus capacity by the winter of 1985-86. Hazelwood 4kV Station, which is on the A6-7 bus will exceed its firm rating in the winter of 1983-84.

The A1-2 bus will exceed its firm rating (based on major transfers to and from Basin Station and load relief off the A4-5 bus) in the winter of 1985-86.

The report indicates that within the next few years a serious overload situation will develop at Carlaw Station and that the range of alternatives to remedy this situation within that time period are very limited.

Carlaw Station Forecast October 20/82

Ex.2 Summary

This forecast includes two transfers. The first transfer involves moving load from the A3-4CE bus to the A3-4 bus in the Fall of 1983. This transfer will be done in conjunction with a service located at 123 Edward St. (University of Toronto Dental Building).

The second transfer proposed will be necessary in the Spring of 1985. Load is to be transferred from A3-4CE bus to the A7-8CE bus. This transfer is expensive due to the length of cable required and the large number of manholes that must be reconstructed.

By transferring load to Terauley Station and between the A3-4 and A7-8 buses at Cecil Station, the limited time rating of the A1-2, A3-4 and A5-6 buses will not be exceeded within the next ten years. The limited time rating of the A7-8 bus will not be exceeded until the winter of 1988/1989 at the earliest.

Presently, the only load connected to the A7-8 bus is University (4kV) Station. The firm rating of this station is 25.05 MVA. The peak load will thus exceed the firm rating in the Winter of 1982/83. It is hoped that as load continues to grow at University Station, load can be converted to supply at 13.8kV from the A7-8 bus.

Cecil Station Forecast November 3/82

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ANNEX 2 - EXAMPLES OF 'RECOMMENDATIONS'

EX.1 Recommendations

1. It is recommended that the A1-2 bus be uprated prior to the A7-8 bus to ensure better station security.

2. It is recommended that ODW (Cadillac Fairview - #1 Dundas St. W.) and RPC (Ryerson Polytechnical Cooling Plant) be transferred to defer the uprating of the A7-8 bus from 54/54 MVA to 72/72 MVA from Spring 1988 to Spring 1990.

3. It is recommended that the Station Planning and Design Department meet with Ontario Hydro to determine whether or not it is possible to uprate the A5-6 bus from 67/72 MVA to 72/72 MVA.

4. It is recommended that the $250,000.00 transfer from Cecil to Terauley be investigated more carefully to determine if a less expensive transfer may be made.

Terauley Station Forecast November 6/81

Ex.2 Recommendations

1. It is recommended that the proposed modifications mentioned in this forecast be implemented by Fall, 1982 in order to relieve the severe overload situation that will occur during Winter 1982-83.

2. Review the load forecast in the Spring of 1983.

3. Begin immediate dialogue between Toronto Hydro and Ontario Hydro on the future layout of Gerrard Station.

Gerrard Station Forecast May 14/82

Ex.3 Recommendations

It is recommended that the Main Station Load Forecast be reviewed in the Spring of 1983 to determine if the transfer proposed for the Fall of 1984 should be advanced to 1983.

Main Station Forecast November 5/81

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ANNEX 3a - SAMPLE CALCULATION OF AREA GROWTH RATES

ACTUAL HISTORIC LOADING (MVA)		ADJUSTED NUMBERS FOR AREA GROWTH RATE CALCULATION	
Summer 1976	41.4	41.1 - 5.0 + 3.0	= 39.4
New Services	0.5		
Transfer	-5.0		
Summer 1977	35.7	35.7 + 3.0	= 38.7
New Services	0.4		
Summer 1978	36.7	36.7 + 3.0	= 39.7
New Services	0.8		
Summer 1979	38.0	38.0 + 3.0	= 41.0
New Services	0.3		
Transfer	+3.0		
Summer 1980	42.5	42.5	= 42.5
New Services	0.2		
Summer 1981	43.0	43.0	= 43.0
New Services	0.3		
Summer 1982	44.0	44.0	= 44.0

AREA GROWTH RATE CALCULATION

ADJUSTED LOADS

Y	LnY
39.4	3.674
38.7	3.656
39.7	3.681
41.0	3.714
42.5	3.750
43.0	3.761
44.0	3.784

Equation of best fit line through LnY

$$\text{LnY} = 0.02179X + 3.63014$$

$$\text{Slope} = m = 0.02179$$

$$\text{Growth} = e^{m} - 1$$

$$= e^{0.02179} - 1$$

$$= 0.022$$

Therefore the area growth rate is 2.2%

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ANNEX 3b - SAMPLE CALCULATION OF BASE GROWTH RATES

ACTUAL HISTORIC LOADING (MVA)		ADJUSTED NUMBERS FOR BASE GROWTH RATE CALCULATION	
Summer 1976	41.4	41.4 + 0.5 - 5.0 + 0.4 + 0.8 + 0.3 + 3.0 + 0.2 + 0.3	= 41.9
New Services	0.5		
Transfer	-5.0		
Summer 1977	35.7	35.7 + 0.4 + 0.8 + 0.3 + 3.0 + 0.2+ 0.3	= 40.7
New Services	0.4		
Summer 1978	36.7	36.7 + 0.8 + 0.3 + 3.0 + 0.2 + 0.3	= 41.3
New Services	0.8		
Summer 1979	38.0	38.0 + 0.3 + 3.0 + 0.2 + 0.3	= 41.8
New Services	0.3		
Transfer	+3.0		
Summer 1980	42.5	42.5 + 0.2 + 0.3	= 43.0
New Services	0.2		
Summer 1981	43.0	43.0 + 0.3	= 43.3
New Services	0.3		
Summer 1982	44.0	44.0	= 44.0

BASE GROWTH RATE CALCULATION:

ADJUSTED NUMBERS

Y	LnY
41.9	3.735
40.7	3.706
41.3	3.721
41.8	3.733
43.0	3.761
43.3	3.768
44.0	3.784

Equation of best fit line through LnY

$$LnY = 0.011104X + 3.69970$$

$$Slope = m = 0.011104$$

$$Growth = e^{m} - 1$$

$$= e^{0.011104} - 1$$

$$= 0.011$$

Therefore the base growth rate is 1.1%

ANNEX 4 - ADJUSTED PROJECTED LOAD GROWTH ON 4kV STATIONS DUE TO ELECTRIC HEATING (MVA)

STATION (4kV)	YEAR									
	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93
Carlaw	.8	.9	1.1	1.0	1.0	.9	.9	.9	.9	.9
Chaplin	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3
College	.7	.8	.9	.9	.8	.8	.8	.8	.8	.8
Commiss.	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
Danforth	.7	.8	.9	.8	.8	.8	.8	.7	.7	.7
Defoe	.3	.3	.4	.4	.4	.4	.3	.3	.3	.3
Dufferin	.5	.6	.7	.6	.6	.6	.6	.6	.6	.6
Dupont	1.0	1.1	1.4	1.3	1.2	1.2	1.1	1.1	1.1	1.1
Eglinton	.6	.7	.8	.7	.7	.7	.7	.6	.6	.6
Forman	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Geo. & Duke	.2	.2	.3	.3	.3	.2	.2	.2	.2	.2
Glengrove	1.2	1.5	1.8	1.6	1.6	1.5	1.5	1.4	1.4	1.4
Hammersmith	.7	.8	1.0	.9	.9	.9	.8	.8	.8	.8
Hazelwood	.6	.7	1.0	.9	.9	.9	.8	.8	.8	.8
High Level	1.1	1.2	1.4	1.3	1.2	1.2	1.2	1.1	1.1	1.1
Junction	.5	.6	.7	.6	.6	.6	.6	.5	.5	.5
Keele & St. Cl.	.3	.3	.4	.4	.4	.4	.3	.3	.3	.3
Kingsway	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Merton	.3	.4	.3	.3	.3	.3	.3	.3	.3	.3
Millwood	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
Ontario	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
Overdale	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2
Parkdale	.5	.6	.7	.7	.7	.6	.6	.6	.6	.6
Queensway	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Rennie Park	.5	.5	.6	.6	.6	.6	.5	.5	.5	.5
Runnymede	.5	.5	.7	.6	.6	.6	.6	.5	.5	.5
Sherbourne	.5	.6	.6	.6	.6	.6	.5	.5	.5	.5
Spadina	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Strachan	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
Terauley	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
University	.5	.5	.6	.5	.5	.5	.5	.5	.5	.5
Wiltshire	.6	.7	.8	.8	.8	.7	.7	.7	.7	.7

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ANNEX 5 - PROCEDURE USED TO ADJUST THE ELECTRIC HEATING PROJECTIONS TO REDUCE THE EFFECT OF COMPOUNDING

YEAR	LOAD* (MVA)	CUMULATIVE LOAD	PERCENT ADJUSTMENT	MVA ADJUSTMENT	ADJUSTED LOAD
82/83	0.80	0.80	1	.01	
83/84	0.81	1.61	1	.02	0.81 - .01 = 0.8
84/85	0.93	2.54	1	.03	0.93 - .02 = 0.9
85/86	1.10	3.64	3	.11	1.10 - .03 = 1.1
86/87	1.10	4.74	3	.14	1.10 - .11 = 1.0
87/88	1.11	5.85	3	.17	1.11 - .14 = 1.0
88/89	1.12	6.97	3	.21	1.12 - .17 = 0.9
89/90	1.13	8.10	3	.24	1.13 - .21 = 0.9
90/91	1.14				1.14 - .24 = 0.9

* Projected load growth on Carlaw 4kV Station due to electric heating (Low scenario).

(One and three % adjustments have been applied to all projections)

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ANNEX 6 - RECOMMENDED BUS GROWTH RATES

		BASE (%)		AREA (%)	
Station	Bus	Summer	Winter	Summer	Winter
BASIN	A1-2BN	1.0	1.0	3.0	3.0
	A3-4BN	1.0	1.0	3.0	3.0
BRIDGMAN	A1-2B	1.0	1.0	2.0	3.0
	A1-2H	1.0	1.0	3.0	3.0
	A3-4H	1.0	1.0	2.0	3.0
	A7-8H	1.0	1.0	3.0	3.0
CARLAW	A1-2E	1.0	1.0	2.0	2.0
	A4-5E	1.0	1.0	2.0	2.0
	A6-7E	1.0	1.0	2.0	2.0
CECIL	A1-2CE	0.0	0.0	1.0	1.0
	A3-4CE	1.0	1.0	3.0	3.0
	A5-6CE	1.0	1.0	2.0	3.0
	A7-8CE	1.0	2.0	2.0	4.0
CHARLES	A1-2CS	2.0	2.0	4.0	4.0
	A3-4CS	2.0	2.0	4.0	4.0
	A5-6CS	2.0	2.0	4.0	4.0
	A7-8CS	1.0	1.0	3.0	3.0
DUFFERIN	A1-2DN	1.0	1.0	2.0	2.0
	A3-4DN	1.0	1.0	2.0	2.0
DUPLEX	A1-2DX	1.0	1.0	3.0	2.0
	A3-4DX	1.0	1.0	2.0	2.0
	A5-6DX	1.0	1.0	3.0	2.0
ESPLANADE	A1-2GD	1.0	1.0	2.0	3.0
	A5-6GD	1.0	1.0	3.0	3.0
GERRARD	B1-2K	1.0	1.0	3.0	3.0

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ANNEX 6 CONTINUED

Station	Bus	BASE (%) Summer	BASE (%) Winter	AREA (%) Summer	AREA (%) Winter
GLENGROVE	A1-2GL	1.0	1.0	2.0	2.0
	A5-6GL	1.0	1.0	2.0	3.0
MAIN	A1-2MN	1.0	1.0	2.0	3.0
	A1-2DA	1.0	1.0	2.0	2.0
STRACHAN	A3-4T	1.0	1.0	3.0	3.0
	A5-6T	1.0	1.0	2.0	2.0
	A7-8T	1.0	1.0	3.0	2.0
TERAULEY	A1-2A	1.0	1.0	3.0	2.0
	A3-4A	1.0	1.0	3.0	3.0
	A5-6A	1.0	1.0	3.0	3.0
	A7-8A	1.0	1.0	3.0	2.0
WILTSHIRE	A1-2W	1.0	1.0	3.0	2.0
	A3-4W	1.0	1.0	3.0	2.0
	A5-6W	1.0	1.0	2.0	2.0
WINDSOR	A1-3-4WR	1.0	1.0	3.0	3.0
	A2-5-6WR	2.0	2.0	5.0	4.0
	A11-12WR	1.0	1.0	2.0	2.0
	A13-14WR	1.0	1.0	2.0	2.0
	A15-16WR	2.0	2.0	5.0	5.0

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ANNEX 7 - EXAMPLES ILLUSTRATING EXPLANATIONS OF 'LOAD GROWTH RATES'

EX.1 Load Growth Rates

The load growth rates used in this forecast were determined from historical data between 1975 and 1982. The base load growths for each bus have been determined by excluding any new loads over 200 kVA. The base load growths are applied up to 1985. The next year's growths are intermediate values calculated by averaging the base and area growths to account for unknown new loads. The area growth rates are applied after 1986.

As load transfers occur between buses, the growth rates are prorated accordingly.

The applied load growth rates are as follows:

Bus	Base	Area	Area (After Load Rearragement)
	S/W	S/W	S/W
A1-2	1.1/0.5	3.1/2.0	4.4/3.8
A3-4	2.5/0.5	2.5/0.5	2.5/0.5
A5-6	2.2/3.2	6.0/6.0	3.7/3.2

Ex.2 Load Growth Rates

The load growth rates applied in this forecast were extracted from the Distribution Planning and Design Load Forecast Methodology dated August 17, 1983. The growth rates are as follows:

Bus	Base (%)	Area (%)
	S/W	S/W
A1-2	1.0/1.0	3.0/3.0
A3-4	1.0/1.0	2.5/2.5
A5-6	1.0/1.0	3.0/3.0

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ANNEX 8 - EXAMPLES ILLUSTRATING EXPLANATIONS OF 'FIRM CAPACITIES'

Ex.1 Firm Capacities

Bus	Present Operating LTR's (MVA)		Interim Reduced LTR's (MVA)	
	Summer	Winter	Summer	Winter
A1-2GL	39	46	-	-
A5-6GL	45	49	43	47

Capacity Increases

1. Replace 2 x 20/33 MVA transformers (T2 and T4) with 2 x 45/75 MVA units.
2. Install third 13.8kV bus

Transformers T2 and T4 presently supply the A5-6GL bus. The firm capacities after the transformers are replaced and third bus is installed will be as follows:

	Summer	Winter
A1-2GL	39	47
A5-6GL	43	47
A7-8GL	43	47

It is possible that with the dual winding transformers installed and only one set of windings utilized, the firm capacities of the A5-6 bus will exceed the present level. Ontario Hydro has to analyze this arrangement further before confirming increased LTR's.

115kV Transmission Limitation

Glengrove T.S. is limited to 120 MVA by the 115kV supply cable between Duplex and Glengrove Stations.

The installation of a third bus will only increase the usable capacity by 26 MVA. This additional capacity will be used up by the winter of 1990-91.

This limitation also prevents any large transfer of Duplex load to Glengrove Station. This constraint makes the deferral of the new Duplex bus impracticable.

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ANNEX 8 CONTINUED

Ex.2 Capacity Increases

	Bus	Capacity Increase Required (MVA) S/W	Date
1)	A3-4	47/47 to 72/72	Spring 1982
2)	A5-6	67/72 to 72/72	Spring 1985
3)	A1-2	40/47 to 72/72	Spring 1985
4)	A7-8	42/47 to 54/54	Spring 1985
5)	A7-8	54/54 to 72/72	Spring 1990

Increase No.	Notes on Capacity Increases
1.	Replace the A3-4 bus and switchgear. This is the in-service date given by the Station Planning and Design Department.
2.	The secondary cables on the Ontario Hydro transformers limit the firm capacity of the A5-6 bus to 67/72 MVA. The Station Planning and Design Department must meet with Ontario Hydro to determine why a reduced rating has been assigned to the cables in summer. This is a new departure.
3.	Replace A1-2 bus and switchgear. Replace T1 and T4 with 75/125 MVA transformers and replace H.E.P.C. secondary cables. M.J. Joannou, Station Planning and Design Department recommends that if possible, the A1-2 switchgear be replaced before the A7-8 bus is uprated to 72/72 MVA, as the A7-8 switchgear is the newest and most secure in Terauley Station and at this time the A1-2 switchgear will be the oldest and least secure.
4.	T1 and T4 limit the A7-8 bus capacity to 42/47 MVA. When these transformers are changed out to uprate A1-2, the firm capacity on A7-8 increases to 54/54 MVA.
5.	Replace incoming breakers and uprate switchgear.

Terauley Station Forecast November 6/81

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ANNEX 9 - EXAMPLE 'LOAD TRANSFER TABLE'

Proposed Load Transfers

DATE	PROPOSED TRANSFER	LOAD S/W (MVA)	FROM	TO	ROUGH COST 1982
Spring '84	NDL & Loc 4740, 4702, 4831	4.0/4.0	A1-2DX	A5-6DX	$ 20,000
Spring '85	All load on A1-2 bus except Eglinton Avenue, East of Yonge Street	24.1/21.3	A1-2DX	A5-6DX	$200,000
Spring '85	Chaplin 4kV, EPE, Eglinton-Henning Vault	16.8/17.2	A5-6DX	A1-2DX	$ 35,000
Spring '87	In conjunction with new bus - Chaplin 4kV, EPE, Eglinton-Henning Vault	18.2/18.5	A1-2DX	A7-8DX	$ 35,000
Fall '87	YEC (Yonge - Eglinton Centre)	10.0/11.0	A3-4DX	A7-8DX	$120,000
Spring '90	A14DX, A15DX Load on Eglinton Avenue West	8.0/10.4	A5-6DX	A7-8DX	$ 30,000

Duplex Station Forecast November 2/82

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ANNEX 10 - EXAMPLE ASSUMPTIONS

ASSUMPTIONS

1. Growth rates and electric heat projections are extracted from the Load Forecast Methodology dated August 17, 1983.
2. Within the next five years, it is anticipated that Merton and Glengrove 4kV Stations will require load relief. Some proposals to convert load to 13.8kV overhead supply are included in this forecast but they do not prevent all overloads on the 4kV stations. To avoid loads in excess of the 4kV station firm ratings, it is assumed that 4kV load will be converted to 13.8kV and supplied from the same bus.
3. The summer 1982 and winter 1982/83 actual peak loads have been increased to 5% to account for the cool summer and warm winter.
4. Service dates of indefinite services have been provided by the Power Service Department.
5. Exceeded reduced LTR's are allowed until 1985.

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ANNEX 11 - EXAMPLES OF A 'RECONCILIATION'

Ex.1

The A1-2 MN bus predicted and actual peak loads are within 1 MVA of each other for the Winter of 1979-80 and for the Summer of 1980. The actual load transferred from the A1-2 MN bus in 1977 was greater than predicted thus compensating for the increased growth rate on the bus. The peak load for the Winter of 1980-81 was 2.5 MVA lower than the previous winter's peak. This drop in load has been attributed to a temporary load reduction at the R.C. Harris Pumping Station and a reduced number of consecutive cold week days. The Winter 1980-81 peak load value was not included in the A1-2MN bus load growth rate calculation.

The A1-2DA bus actual winter peaks have been 2 to 4 MVA less than the predicted values. This difference has been attributed to energy conservation which has slightly reduced the growth rate.

Main Station Forecast November 5/81

Ex.2

Summer Peaks 1981

The predicted and actual 1981 summer peak loads were approximately equal for the A1-2 bus and the A5-6 bus. The A3-4 bus actual summer peak load was 2.1 MVA less than the predicted peak load. This difference again can be attributed to a reduced growth rate on the bus.

Winter Peaks 1981-82

The actual and predicted 1981/82 winter peak loads for the A5-6 bus were identical. The A3-4 bus experienced less growth than what was predicted thus accounting for the 3.9 MVA difference in predicted and actual loads.

The added load on the A1-2 bus from new services and a transfer not included in the 1979 forecast approximately equalled the effects of deferred and reduced load from predicted services. The 4.3 MVA difference between the predicted and actual load is due to the reduced growth rate on the bus.

Duplex Station Forecast April 16/82

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ANNEX 12 - EXAMPLE OF AN ABBREVIATION TABLE

Abbreviations

BK TTC	Berwick TTC
CP	Chaplin
CPS	Colonia Life Holdings - 2 St. Clair East
DS TTC	Davisville TTC
EG	Eglinton
EPE	Eglinton Park Arena - 180 Eglinton Ave. West
EWP	TTC Eglinton West Passenger Station
GA TTC	Glenayr TTC
NDL	North Toronto District Library - 49 Orchardview
NT TTC	North Toronto TTC
OTE	110 Eglinton East Development
PH TTC	Park Hill TTC
SA	Spadina
WCS	Wittington Realty - 22 St. Clair East
YEC	Yonge Eglinton Centre - 20 Eglinton Ave. West

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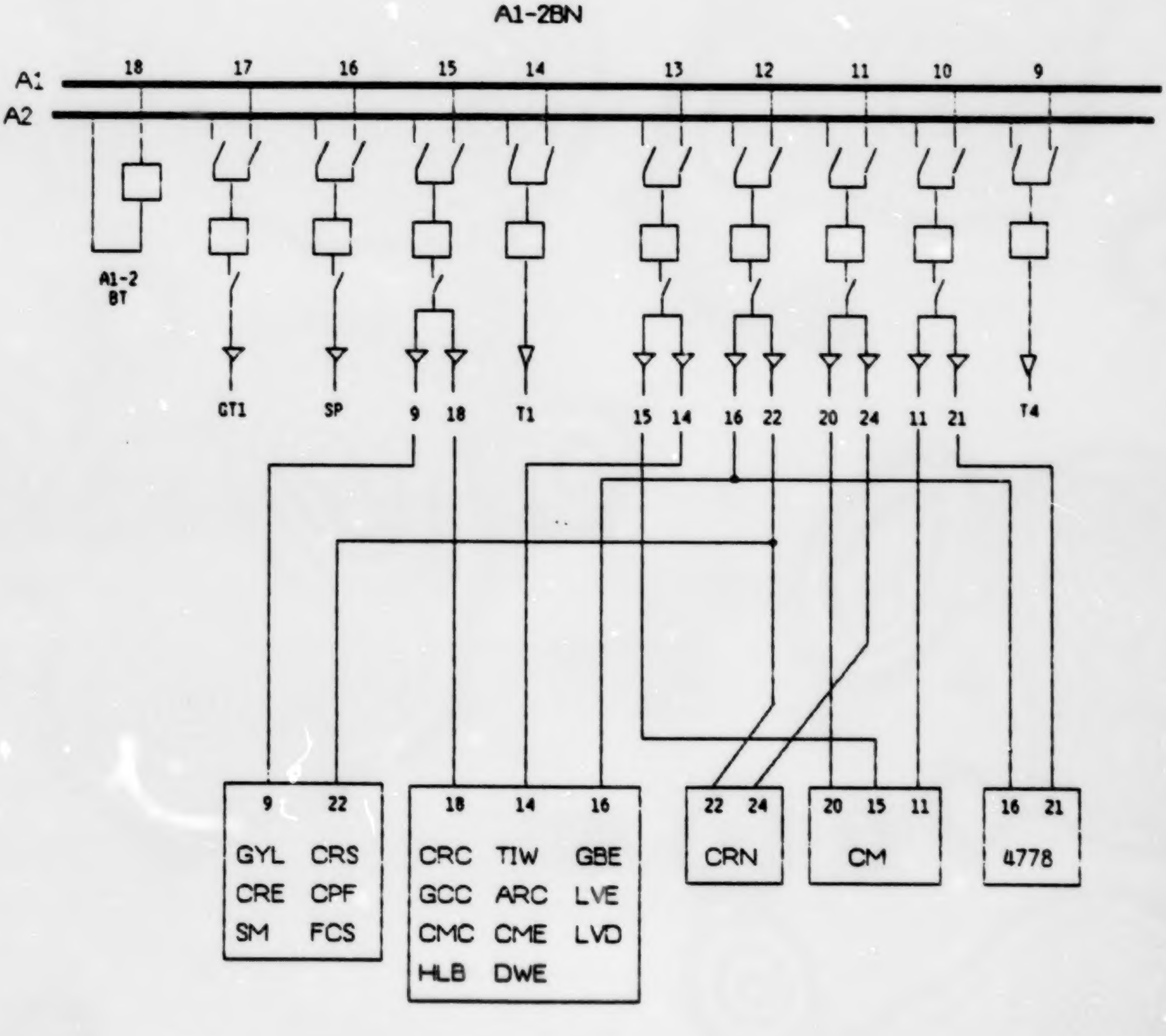
ANNEX 13 - EXAMPLE SWITCHGEAR ARRANGEMENT


A1-2BN
A1
A2
18
17
16
15
14
13
12
11
10
9
A1-2
BT
GT1
SP
9
18
T1
15
14
16
22
20
24
11
21
T4
9 22
GYL CRS
CRE CPF
SM FCS
18 14 16
CRC TIW GBE
GCC ARC LVE
CMC CME LVD
HLB DWE
22 24
CRN
20 15 11
CM
16 21
4778

APPENDIX G

13.8kV BUS LOAD FORECASTS

SUMMER PEAK LOADS MVA

STATION	BUS	ACTUAL 1983	1984	1985	1986	1987	1988	1989	1990	1991
BASIN	A1-2	32.0	35.0	36.8	40.4	39.5	23.4	24.9	25.6	26.4
	A3-4	36.9	38.6	40.5	42.0	45.4	46.8	31.9	32.9	33.9
	A5-6						22.1	39.1	40.3	41.5
BRIDGMAN	A1-2B	29.2	30.8	32.5	36.2	36.2	36.9	37.6	38.4	39.2
	A1-2H	45.7	48.7	51.2	52.7	54.5	56.1	57.8	59.5	61.3
	A3-4H	32.5	32.8	29.9	27.7	28.3	28.9	27.4	27.9	28.5
	A7-8H	34.6	36.3	37.7	41.1	45.7	47.1	50.6	52.1	53.7
CARLAW	A1-2	25.4	33.8	34.5	38.0	38.8	36.8	37.5	38.2	39.0
	A6-7	24.8	25.2	25.5	26.0	26.5	27.0	26.9	27.4	27.9
CECIL	A1-2	31.6	31.6	31.6	31.9	32.2	32.5	32.8	33.1	33.4
	A3-4	48.0	49.9	51.1	39.6	41.2	42.4	37.7	38.8	40.0
	A5-6	27.0	27.3	31.0	31.6	32.2	32.8	33.5	34.2	34.9
	A7-8	21.9	22.1	21.6	36.0	34.9	35.6	36.3	37.0	37.7
CHARLES	A1-2	24.7	25.7	27.0	34.8	36.2	37.6	36.8	38.3	39.8
	A3-4	44.1	48.1	48.0	38.9	41.7	35.8	37.6	39.5	41.5
	A5-6	37.0	40.0	40.4	41.2	42.0	42.8	43.7	44.6	45.5
	A7-8	25.7	28.6	29.7	36.6	41.7	51.0	56.2	57.9	59.6
DUFFERIN	A1-2	38.4	38.8	36.6	37.2	37.9	38.7	39.5	40.3	41.1
	A3-4	40.8	41.2	41.5	40.7	35.5	36.2	35.9	36.6	37.3
	A5-6			9.5	15.5	29.8	32.6	36.4	37.8	38.6
DUPLEX	A1-2	45.8	34.1	34.4	39.0	40.2	41.4	11.3	12.3	12.7
	A3-4	31.1	31.6	33.7	35.2	36.3	37.4	36.4	37.5	38.6
	A5-6	22.6	37.6	38.0	36.6	37.8	38.9	38.7	40.3	41.5
	A7-8							38.3	39.4	40.6
ESPLANADE	A1-2GD	49.0	46.6	48.1	53.9	55.8	58.0	46.8	45.0	45.9
	A5-6GD	52.0	55.9	57.8	60.0	61.6	63.4	65.3	67.3	69.3
	A1-2X							12.4	15.5	16.0

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SUMMER PEAK LOADS MVA

STATION	BUS	1992	1993	1994	1995	1996	1997	1998	1999	2000
BASIN	A1-2	27.2	28.0	28.8	29.7	30.6	31.5	32.5	33.4	34.4
	A3-4	34.9	35.9	37.0	38.1	39.2	40.4	41.6	42.9	44.2
	A5-6	42.7	44.0	45.3	46.7	48.1	49.5	51.0	52.5	54.1
BRIDGMAN	A1-2B	40.0	40.8	41.6	42.4	43.3	44.2	45.0	45.9	46.9
	A1-2H	63.1	65.0	67.0	69.0	71.0	73.2	75.4	77.6	79.9
	A3-4H	29.1	29.7	30.3	30.9	31.5	32.1	32.8	33.4	34.1
	A7-8H	55.3	57.0	58.7	60.5	62.3	64.2	66.1	68.1	70.1
CARLAW	A1-2	39.8	40.6	41.4	42.2	43.1	43.9	44.8	45.7	46.6
	A6-7	28.5	29.1	29.7	30.3	30.9	31.5	32.1	32.8	33.4
CECIL	A1-2	33.7	34.0	34.3	34.7	35.0	35.4	35.7	36.1	36.5
	A3-4	41.2	42.4	43.7	45.0	46.3	47.7	49.2	50.6	52.1
	A5-6	35.6	36.3	37.0	37.8	38.5	39.3	40.1	40.9	41.7
	A7-8	38.5	39.3	40.1	40.9	41.7	42.5	43.4	44.3	45.1
CHARLES	A1-2	41.4	43.1	44.8	46.6	48.5	50.4	52.4	54.5	56.7
	A3-4	43.6	45.8	48.1	50.5	53.0	55.7	58.5	61.4	64.4
	A5-6	46.4	47.3	48.2	49.2	50.2	51.2	52.2	53.3	54.3
	A7-8	61.4	63.2	65.1	67.0	69.1	71.1	73.3	75.5	77.7
DUFFERIN	A1-2	41.9	42.7	43.6	44.4	45.3	46.2	47.1	48.1	49.0
	A3-4	38.0	38.8	39.6	40.4	41.2	42.0	42.8	43.7	44.6
	A5-6	39.4	40.2	41.0	41.8	42.7	43.5	44.4	45.3	46.2
DUPLEX	A1-2	28.7	29.6	30.5	31.4	32.3	33.3	34.3	35.3	36.4
	A3-4	29.8	30.7	31.6	32.6	33.5	34.6	35.6	36.7	37.8
	A5-6	37.1	38.2	39.3	40.5	41.7	43.0	44.3	45.6	47.0
	A7-8	41.8	43.1	44.4	45.7	47.1	48.5	50.0	51.5	53.0
ESPLANADE	A1-2GD	46.8	47.7	48.7	49.6	50.6	51.6	52.7	53.7	54.8
	A5-6GD	71.4	73.5	75.7	78.0	80.3	82.7	85.2	87.8	90.4
	A1-2X	16.5	17.0	17.5	18.0	18.6	19.1	19.7	20.3	20.9

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SUMMER PEAK LOADS MVA

STATION	BUS	ACTUAL 1983	1984	1985	1986	1987	1988	1989	1990	1991
GERRARD	B1-2K	24.8	23.7	26.6	26.9	25.9	26.7	27.5	28.3	29.1
	A4-5E	33.7	27.9	28.2	27.2	25.7	24.2	23.9	24.4	24.9
GLENGROVE	A1-2	22.5	22.5	22.7	22.2	22.9	23.6	22.9	23.6	24.3
	A5-6	28.2	28.5	28.8	27.2	28.0	28.8	27.6	28.4	29.3
	A7-8									
JOHN	A3-4	39.4	44.6	54.1	60.3	56.6	60.7	62.5	64.4	66.3
	A5-6	49.0	58.1	58.6	54.7	57.4	60.9	63.9	67.1	70.5
	A11-12	56.7	57.3	57.9	58.5	59.1	59.7	60.3	60.9	61.5
	A13-14	37.7	41.4	41.8	42.6	40.0	40.8	41.6	42.4	43.2
	A15-16	49.3	57.8	60.6	60.1	63.1	63.7	65.6	67.6	69.6
	A17-18			8.4	16.9	29.6	34.6	36.9	39.3	40.9
MAIN	A1-2MN	38.5	38.8	39.2	34.4	35.1	35.8	36.1	35.4	36.1
	A3-4MN				4.0	7.5	7.6	7.8	10.8	11.0
	A1-2DA	19.1	19.2	19.4	20.0	19.0	19.4	20.8	19.8	20.2
STRACHAN	A3-4	35.5	36.2	38.1	39.9	41.8	33.3	35.4	36.5	37.6
	A5-6	25.5	25.8	26.0	27.3	27.5	22.5	22.9	22.9	23.4
	A7-8	36.8	39.2	39.6	40.1	41.2	36.5	36.5	37.6	38.7
	A9-10						22.6	23.1	23.6	24.1
TERAULEY	A1-2	32.5	37.8	39.6	41.2	45.8	53.2	63.8	68.7	70.8
	A3-4	48.4	55.9	58.9	61.6	63.7	65.6	67.6	69.6	71.7
	A5-6	54.6	58.8	61.4	64.3	61.2	64.1	67.9	70.3	72.4
	A7-8	34.6	34.2	34.9	34.7	43.3	44.6	45.9	47.3	48.7
WILTSHIRE	A1-2	35.2	30.6	31.6	30.4	26.6	27.1	27.6	28.2	28.8
	A3-4	33.6	37.2	36.4	38.9	37.6	36.4	36.9	37.6	38.4
	A5-6	42.2	42.2	43.0	40.6	41.4	42.2	40.9	41.5	42.3

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SUMMER PEAK LOADS MVA

STATION	BUS	1992	1993	1994	1995	1996	1997	1998	1999	2000
GERRARD	B1-2K	30.0	30.9	31.8	32.8	33.8	34.8	35.8	36.9	38.0
	A4-5E	25.4	25.9	26.4	26.9	27.5	28.0	28.6	29.2	29.8
GLENGROVE	A1-2	25.0	25.7	26.5	27.3	28.1	28.9	29.8	30.7	31.6
	A5-6	30.2	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.4
	A7-8		8.8	9.1	9.3	9.6	9.9	10.2	10.5	10.8
JOHN	A3-4	68.3	70.3	72.4	74.6	76.8	79.1	81.5	83.9	86.5
	A5-6	74.0	77.7	81.6	85.7	89.9	94.4	99.2	104.1	109.3
	A11-12	62.1	62.7	63.3	64.0	64.6	65.2	65.9	66.6	67.2
	A13-14	44.1	45.0	45.9	46.8	47.8	48.7	49.7	50.7	51.7
	A15-16	71.7	73.9	76.1	78.4	80.8	83.2	85.7	88.2	90.9
	A17-18	42.5	44.2	46.0	47.8	49.7	51.7	53.8	55.9	58.2
MAIN	A1-2MN	36.8	37.5	38.3	39.0	39.8	40.6	41.4	42.2	43.1
	A3-4MN	11.2	11.4	11.6	11.9	12.1	12.3	12.6	12.8	13.1
	A1-2DA	20.6	21.0	21.4	21.8	22.3	22.7	23.2	23.6	24.1
STRACHAN	A3-4	38.7	39.9	41.1	42.3	43.6	44.9	46.3	47.6	49.1
	A5-6	23.9	24.4	24.9	25.4	25.9	26.4	26.9	27.5	28.0
	A7-8	39.9	41.1	42.3	43.6	44.9	46.3	47.6	49.1	50.5
	A9-10	24.6	25.1	25.6	26.1	26.6	27.2	27.7	28.3	28.8
TERAULEY	A1-2	72.9	75.1	77.4	79.7	82.1	84.5	87.1	89.7	92.4
	A3-4	73.9	76.1	78.4	80.7	83.2	85.7	88.2	90.9	93.6
	A5-6	74.6	76.8	79.1	81.5	83.9	86.4	89.0	91.7	94.5
	A7-8	50.2	51.7	53.3	54.8	56.5	58.2	59.9	61.7	63.6
WILTSHIRE	A1-2	29.4	30.0	30.6	31.2	31.8	32.5	33.1	33.8	34.5
	A3-4	39.2	40.0	40.8	41.6	42.4	43.3	44.2	45.0	45.9
	A5-6	43.1	44.0	44.9	45.8	46.7	47.6	48.6	49.6	50.5

NOTE: The effects of load transfers to alleviate overloaded buses are included only for the first five years.

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13.8kV BUS LOAD FORECASTS

WINTER PEAK LOADS MVA

		ACTUAL									
STATION	BUS	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
BASIN	A1-2	33.9	31.5	36.8	41.8	40.3	24.2	26.2	27.2	28.2	29.2
	A3-4	36.4	37.6	39.1	40.8	45.3	46.7	32.1	33.1	34.1	35.1
	A5-6						22.7	38.7	39.9	41.1	42.3
BRIDGMAN	A1-2B	31.5	33.7	36.1	41.8	41.5	42.7	44.0	45.3	46.7	48.1
	A1-2H	39.1	43.5	46.7	49.2	51.2	52.7	54.3	55.9	57.6	59.3
	A3-4H	39.1	43.2	39.9	37.7	39.0	40.3	38.6	39.9	41.3	42.8
	A7-8H	28.8	32.1	34.6	39.7	44.9	46.2	50.6	52.1	53.7	55.3
CARLAW	A1-2	26.0	36.0	38.5	42.8	43.7	41.9	42.7	43.6	44.5	45.4
	A6-7	30.5	33.6	34.6	36.1	37.6	39.2	40.0	41.6	43.2	44.9
CECIL	A1-2	26.3	27.6	27.6	27.6	27.9	28.2	28.5	28.8	29.1	29.4
	A3-4	36.1	40.1	41.9	43.9	34.6	35.6	36.7	32.8	33.8	34.8
	A5-6	20.9	22.1	27.0	27.3	28.1	28.9	29.8	30.7	31.6	32.5
	A7-8	24.9	26.2	26.2	27.3	35.9	37.8	39.8	41.9	44.1	46.4
CHARLES	A1-2	35.5	39.1	40.7	34.2	43.6	45.3	39.8	41.4	43.1	44.8
	A3-4	38.9	43.5	43.1	45.1	38.3	40.9	36.5	38.3	40.2	42.2
	A5-6	33.1	37.8	38.7	39.1	39.9	40.7	41.5	42.3	43.1	44.0
	A7-8	23.9	28.5	29.9	40.8	49.6	51.1	68.3	70.3	72.4	74.6
DUFFERIN	A1-2	38.7	43.6	40.3	41.9	44.0	45.4	46.8	48.2	49.8	51.4
	A3-4	50.2	50.2	51.1	50.5	45.0	46.6	46.7	48.3	50.0	51.7
	A5-6			13.6	22.2	41.7	46.4	52.6	55.4	57.2	59.0
DUPLEX	A1-2	42.0	46.6	33.6	40.0	40.4	41.6	15.7	17.2	17.7	29.2
	A3-4	33.2	35.7	37.4	41.1	42.5	44.5	43.5	45.5	47.5	38.5
	A5-6	21.6	23.1	38.0	36.3	37.5	38.9	38.4	40.5	42.0	43.6
	A7-8							37.1	38.2	39.3	40.5
ESPLANADE	A1-2GD	49.0	50.4	52.0	58.4	60.9	63.6	52.9	51.3	52.6	54.0
	A5-6GD	38.9	43.1	46.5	48.5	49.8	51.3	52.8	54.4	56.0	57.7
	A1-2X							12.3	15.7	16.2	16.7

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WINTER PEAK LOADS MVA

STATION	BUS	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01
BASIN	A1-2	30.3	31.4	32.3	33.3	34.3	35.3	36.4	37.5	38.6
	A3-4	36.2	37.3	38.4	39.6	40.8	42.0	43.2	44.5	45.9
	A5-6	43.6	44.9	46.2	47.6	49.1	50.5	52.1	53.6	55.2
BRIDGMAN	A1-2B	49.5	51.0	52.5	54.1	55.7	57.4	59.1	60.9	62.7
	A1-2H	61.1	62.9	64.8	66.7	68.7	70.8	72.9	75.1	77.4
	A3-4H	44.3	44.7	45.1	45.6	46.1	46.5	47.0	47.4	47.9
	A7-8H	57.0	58.7	60.5	62.3	64.1	66.1	68.0	70.1	72.2
CARLAW	A1-2	46.3	47.2	48.1	49.1	50.1	51.1	52.1	53.2	54.2
	A6-7	46.6	47.5	48.5	49.4	50.4	51.4	52.4	53.5	54.6
CECIL	A1-2	29.7	30.0	30.3	30.6	30.9	31.2	31.5	31.8	32.2
	A3-4	35.8	36.9	38.0	39.1	40.3	41.5	42.8	44.1	45.4
	A5-6	33.5	34.5	35.5	36.6	37.7	38.8	40.0	41.2	42.4
	A7-8	48.8	50.8	52.8	54.9	57.1	59.4	61.8	64.3	66.8
CHARLES	A1-2	46.6	48.5	50.4	52.5	54.6	56.7	59.0	61.4	63.8
	A3-4	44.3	46.5	48.8	51.3	53.8	56.5	59.3	62.3	65.4
	A5-6	44.9	45.8	46.7	47.7	48.6	49.6	50.6	51.6	52.6
	A7-8	76.8	79.1	81.5	83.9	86.4	89.0	91.7	94.4	97.3
DUFFERIN	A1-2	53.0	54.7	55.8	56.9	58.0	59.2	60.4	61.6	62.8
	A3-4	53.4	55.2	56.3	57.4	58.6	59.8	60.9	62.2	63.4
	A5-6	60.9	62.8	64.1	65.3	66.6	68.0	69.3	70.7	72.1
DUPLEX	A1-2	36.9	38.0	39.1	40.3	41.5	42.8	44.1	45.4	46.7
	A3-4	40.3	42.1	43.4	44.7	46.0	47.4	48.8	50.3	51.8
	A5-6	38.4	39.9	41.1	42.3	43.6	44.9	46.3	47.6	49.1
	A7-8	41.7	43.0	44.3	45.6	47.0	48.4	49.8	51.3	52.9
ESPLANADE	A1-2GD	55.4	56.5	57.6	58.8	60.0	61.2	62.4	63.6	64.9
	A5-6GD	59.4	61.2	63.0	64.9	66.9	68.9	70.9	73.1	75.3
	A1-2X	17.2	17.7	18.2	18.8	19.3	19.9	20.5	21.1	21.8

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WINTER PEAK LOADS MVA

STATION	BUS	ACTUAL 82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92
GERRARD	B1-2K	28.0	31.9	33.8	36.9	35.6	37.3	39.0	40.7	42.4	44.2
	A4-5E	43.1	41.9	41.2	41.1	40.4	39.7	40.3	42.0	43.7	45.5
GLENGROVE	A1-2	29.3	31.2	31.9	31.0	31.9	33.2	32.5	33.8	35.1	36.5
	A5-6	33.7	37.5	39.4	38.6	40.8	43.6	43.4	46.2	49.0	51.9
	A7-8										
JOHN	A3-4	30.7	42.6	45.2	52.1	56.2	51.2	54.7	56.3	58.0	59.7
	A5-6	41.3	46.1	52.5	56.1	52.8	55.7	57.9	60.2	62.6	65.1
	A11-12	50.6	53.6	54.1	54.6	55.1	55.7	56.3	56.9	57.5	58.1
	A13-14	26.7	28.3	32.6	33.3	34.0	31.2	31.8	32.4	33.0	33.7
	A15-16	39.5	55.2	60.3	62.6	62.6	63.2	65.1	67.1	69.1	71.2
	A17-18				7.2	16.7	32.4	34.6	36.9	38.4	39.9
MAIN	A1-2MN	42.4	46.3	48.5	43.9	45.2	47.5	49.4	49.7	52.0	54.4
	A3-4MN				4.5	9.1	9.6	10.1	14.6	15.2	15.9
	A1-2DA	23.9	25.4	26.5	28.3	27.4	28.7	31.3	30.7	32.1	33.4
STRACHAN	A3-4	35.5	38.4	40.6	42.3	44.9	37.3	40.2	41.7	43.3	44.9
	A5-6	33.5	36.1	36.0	38.7	39.9	36.3	38.6	39.3	40.7	42.1
	A7-8	35.5	41.8	43.0	42.8	43.9	39.2	38.9	40.0	41.1	42.2
	A9-10						21.9	22.3	22.7	23.2	23.7
TERAULEY	A1-2	25.4	32.5	33.8	35.0	36.4	40.9	48.1	57.5	62.2	64.1
	A3-4	45.2	53.2	56.1	56.9	58.6	60.4	62.2	64.1	66.0	68.0
	A5-6	45.0	54.5	58.2	62.0	67.0	62.9	66.7	69.1	71.2	73.3
	A7-8	28.1	31.0	31.4	30.6	32.0	39.0	40.3	41.6	42.9	44.3
WILTSHIRE	A1-2	37.1	43.8	39.1	39.4	34.6	36.5	38.3	40.2	42.1	44.0
	A3-4	33.6	35.3	40.4	43.5	42.5	41.5	42.3	43.7	45.1	46.5
	A5-6	52.3	56.7	58.2	56.9	58.4	61.4	61.3	63.9	66.8	69.7

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WINTER PEAK LOADS MVA

STATION	BUS	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01
GERRARD	B1-2K	46.0	47.9	49.3	50.8	52.3	53.9	55.5	57.2	58.9
	A4-5E	47.3	49.1	50.1	51.1	52.1	53.1	54.2	55.3	56.4
GLENGROVE	A1-2	37.9	39.3	40.5	41.7	42.9	44.2	45.6	46.9	48.3
	A5-6	44.6	47.3	48.7	50.2	51.7	53.2	54.8	56.5	58.2
	A7-8	10.3	10.6	10.9	11.2	11.6	11.9	12.3	12.7	13.0
JOHN	A3-4	61.5	63.3	65.2	67.2	69.2	71.2	73.4	75.6	77.9
	A5-6	67.7	70.4	73.2	76.1	79.2	82.4	85.7	89.1	92.6
	A11-12	58.7	59.3	59.9	60.5	61.1	61.7	62.3	62.9	63.6
	A13-14	34.4	35.1	35.8	36.5	37.2	38.0	38.8	39.5	40.3
	A15-16	73.3	75.5	77.8	80.1	82.5	85.0	87.5	90.2	92.9
	A17-18	41.5	43.2	44.9	46.7	48.6	50.5	52.6	54.7	56.8
MAIN	A1-2MN	56.8	59.3	61.1	62.9	64.8	66.7	68.7	70.8	72.9
	A3-4MN	16.6	17.3	17.8	18.4	18.9	19.5	20.1	20.7	21.3
	A1-2DA	34.8	36.2	36.9	37.7	38.4	39.2	40.0	40.8	41.6
STRACHAN	A3-4	46.5	48.2	49.6	51.1	52.7	54.2	55.9	57.6	59.3
	A5-6	43.5	45.0	45.9	46.8	47.8	48.7	49.7	50.7	51.7
	A7-8	43.3	44.5	45.4	46.3	47.2	48.2	49.1	50.1	51.1
	A9-10	24.2	24.7	25.2	25.7	26.2	26.7	27.3	27.8	28.4
TERAULEY	A1-2	66.0	68.0	70.0	72.1	74.3	76.5	78.8	81.2	83.6
	A3-4	70.0	72.1	74.3	76.5	78.8	81.1	83.6	86.1	88.7
	A5-6	75.5	77.8	80.1	82.5	85.0	87.6	90.2	92.9	95.7
	A7-8	45.7	47.1	48.5	50.0	51.5	53.0	54.6	56.2	57.9
WILTSHIRE	A1-2	46.0	47.9	48.9	49.8	50.8	51.8	52.9	53.9	55.0
	A3-4	47.9	49.4	50.4	51.4	52.4	53.5	54.5	55.6	56.7
	A5-6	72.7	75.8	77.3	78.9	80.4	82.0	83.7	85.4	87.1

NOTE: The effects of load transfers to alleviate overloaded buses are included only for the first five years.

APPENDIX H

LIMITED TIME RATINGS OF EXISTING FACILITIES

Joint Electrical Energy Planning Committee, August 1984

TABLE H-1
LIMITED TIME RATINGS
OF EXISTING STATION 13.8 kV BUSES

Station	Transformer Operating Designation (Nameplate Rating - MVA)	13.8 kV Bus Operating Designation (Supply Transformers)	13.8 kV Bus LTR-MVA (Limiting Elem. if not Trfm.) Summer	Winter
Basin TS	T1 (20/33) T3 (45/75) T4 (20/33) T5 (45/75)	A1A2 (T1, T4) A3A4 (T3X, T5X) (The Y windings of T3 & T5 are idle)	41 (cable) 48 (breaker)	44 (cable) 54 (breaker)
Bridgman TS	T5 (19/31) T6 (20/33) T11 (40/66) T12 (40/66) T13 (40/66) T14 (45/75)	A1A2B (T12Y, T13Y) A1A2H (T11Y, T13X, T14X) A3A4H (T5, T11X) A7A8H (T6, T12X) (The Y winding of T14 is idle)	39 66 (reactors) 36 39	45 66 (reactors) 40 45
Carlaw TS	T1 (45/75) T2 (45/75)	A1A2 (T1A, T2A) A6A7 (T1B, T2B)	45 (cable) 45 (cable)	47 (breaker) 47 (breaker)
Cecil TS	T1 (45/75) T2 (45/75) T3 (45/75) T4 (45/75)	A1A2 (T1A, T2A) A3A4 (T1B, T2B) A5A6 (T3B, T4B) A7A8 (T3A, T4A)	46 46 47 47	46 46 51 51
Charles TS	T1 (45/75) T2 (45/75) T3 (45/75) T4 (45/75)	A1A2 (T3X, T4X) A3A4 (T3Y, T4Y) A5A6 (T1X, T2X) A7A8 (T1Y, T2Y)	42 42 47 47	47 47 51 51

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LIMITED TIME RATINGS OF EXISTING STATION 13.8 kV BUSES

<table>
<tr><th rowspan="2">Station</th><th rowspan="2">Transformer Operating Designation (Nameplate Rating - MVA)</th><th rowspan="2">13.8 kV Bus Operating Designation (Supply Transformers)</th><th colspan="2">13.8 kV Bus LTR-MVA (Limiting Elem. if not Trfm.)</th></tr>
<tr><th>Summer</th><th>Winter</th></tr>
<tr><td>Dufferin TS</td><td>T1 (40/80)
T2 (45/75)</td><td>A1A2 (T1X, T2X)
A3A4 (T1Y, T2Y)</td><td>48
48</td><td>54
54</td></tr>
<tr><td>Duplex TS</td><td>T1 (45/75)
T2 (45/75)
T3 (45/75)
T4 (45/75)</td><td>A1A2 (T1X, T2X)
A3A4 (T1Y, T2Y)
A5A6 (T3X, T4X)
(The Y windings of T3 & T4 are idle)</td><td>42
42
59</td><td>48
48
59 (breaker)</td></tr>
<tr><td>Esplanade TS</td><td>T1 (20/33)
T3 (20/33)
T5 (20/33)
T6 (20/33)</td><td>A1A2 GD* (T1, T2, T5, T6)
A5A6 GD* (T1, T2, T5, T6)
*Located at George & Duke Station.</td><td>66
66</td><td>66
66</td></tr>
<tr><td>Gerrard TS</td><td>T1 (20/33)
T2 (20/33)
T3 (20/33)
T4 (20/33)</td><td>A4A5* (T1, T4)
*Located at Carlaw TS
B1B2 (T2, T3)</td><td>35 (bus)
35 (bus)</td><td>41 (cable)
46 (cable)</td></tr>
<tr><td>Glengrove TS</td><td>T1 (20/33)
T2 (20/33)
T3 (20/33)
T4 (20/33)</td><td>A1A2 (T1, T3)
A5A6 (T2, T4)</td><td>39
45</td><td>47
53</td></tr>
</table>

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LIMITED TIME RATINGS
OF EXISTING STATION 13.8 kV BUSES

Station	Transformer Operating Designation (Nameplate Rating - MVA)	13.8 kV Bus Operating Designation (Supply Transformers)	13.8 kV Bus LTR-MVA (Limiting Elem. if not Trfm.)	
			Summer	Winter
John TS	T1 (45/75)	A3A4A5A6 (T1X, T3, T2X, T4X)	129 (reactors)	129 reactors)
	T2 (45/75)			
	T3 (20/33)	A11A12 (T5X, T6X)	71	72
	T4 (45/75)	A13A14 (T2Y, T4Y)	48 (M/C)	48 (M/C)
	T5 (75/125)	A15A16 (T5Y, T6Y)	71	72
	T6 (75/125)	(The Y winding of T1 is idle)		
Main TS	T3 (45/75)	A1A2D* (T3X, T4X) *Located at Danforth Sub.	15 (cable)	15 (cable)
	T4 (45/75)	A1A2M (T3Y, T4Y)	47	51
Strachan TS	T11 (40/66)	A3A4 (T13Y, T15Y)	48	53
	T12 (40/66)	A5A6 (T11Y, T12Y)	39 (cable)	41 (cable)
	T13 (45/75)	A7A8 (T13X, T15X)	48 (breaker)	53
	T15 (45/75)	(The X windings of T11 & T12 are idle)		
Terauley TS	T1 (75/125)	A1A2 (T1Y, T4Y)	36 (bus)	44 (bus)
	T2 (75/125)	A3A4 (T2Y, T3X)	72	72
	T3 (75/125)	A5A6 (T2X, T3Y)	68 (breaker)	72
	T4 (75/125)	A7A8 (T1X, T4X)	47 (cable)	55 (cable)
Wiltshire TS	T1 (3x16, 1 phase)	A1A2 (T2, T5)	35	41
	T2 (20/33)			
	T3 (20/33)	A3A4 (T3, T4)	39	46
	T4 (20/33)			
	T5 (20/33)	A5A6 (T1, T6)	58	68
	T6 (3x16, 1 phase)			

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TABLE H-2
LIMITED TIME RATINGS FOR EXISTING 230-115 kV TRANSFORMATION

Station	Transformer Operating Designation (Nameplate Rating-MV.A)		115 kV Switchyard Operating Designation (Transformer Supply)	115 kV Switchard LTR - MV.A Summer		Winter	
				½-hour	10-day	½-hour	10-day
A. W. Manby TS	T1	(250)	J-P - West T1, T2, T12)	627(1)	525	696(1)	570
	T2	(215)					
	T7	(250)					
	T8	(225)	D-E - East (T7, T8, T9)	655(2)	634	736(2)	666
	T9	(250)					
	T12	(250)					
Leaside TS	T11	(250)	JP - EK (T11,T12,T14,T16,T17)	1220(3)	1220(3)	1220(3)	1220(30)
	T12	(250)					
	T14	(250)					
	T16	(250)					
	T17	(250)					

Notes:

(1) Loading to ½-hour LTR is permitted since transfer capability is available to reduce the load to within the 10-day rating.

(2) Limited by the emergency rating of 115 kV transmission circuits to Wiltshire TS.

(3) Limited by the 230 kV system configuration which causes unequal load sharing between transformers.

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TABLE H-3
SUMMER RATINGS OF EXISTING 115 kV TRANSMISSION CIRCUITS

Line of Section (Circuit Designations)	Rating - MV.A with One Circuit in the Section Out of Service
Manby E x Wiltshire (K1W, K3W, K11W, K12W)	655
Wiltshire x Bridgman (L13W, L14W, L15W)	424
Bridgman x Leaside (L13W, L14W, L15W)	280
Manby x Strachan (K6J, H2JK, K13J, K14J)	490
Strachan x John (K6J, H2JK, K13J, K14J)	600
Leaside x Charles (L9X, L12K)	212
Charles x Cecil (C9X, C2X)	180
Cecil x Terauley (A2C, A9C)	180
Terauley x Esplanade (T5E, T7E)	165
Explanade x Hearn (H5E, H7E)	253
Hearn x Gerrard St. Jct. (H6LC, H8LC)	226
Gerrard St. Jct. x Cecil (H6LC, H8LC)	207
Gerrard St. Jct. x Leaside (H6LC, H8LC)	232

TABLE H-3
SUMMER RATINGS OF EXISTING 115 kV TRANSMISSION CIRCUITS

Line of Section (Circuit Designations)	Rating - MV.A with One Circuit in the Section Out of Service
Leaside x Gerrard (H1L, H3L)	232
Gerrard x Basin (H1L, H3L)	138
Basin x Hearn (H1L, H3L)	254
Hearn & Main (H7SL, H11SL)	186
Main x Lumsden Jct. (H7SL, H11SL)	126
Lumsden Jct. x Leaside (H7SL, H11SL)	140
Leaside x Duplex (L5D, L16D)	200
Duplex x Glengrove (D6Y - single circuit)	120
Glengrove x Leaside (L2Y - single circuit)	207
Hearn x John (H2JK - single circuit normally out of service)	200

APPENDIX I

TRANSFORMER STATION SUMMER PEAK LOAD FORECASTS (MVA)

COINCIDENT WITH TORONTO HYDRO SYSTEM PEAK

Station	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Basin	61	65	68	70	76	79	81	84	86	88	91	94	96	98	102	105	107
Bridgman	139	141	147	153	156	160	164	168	171	175	180	184	189	193	198	203	208
Carlaw	53	54	58	59	57	58	59	60	61	62	64	64	65	66	68	69	70
Cecil	122	126	128	129	131	128	130	133	135	138	141	143	146	149	151	154	157
Charles	138	141	146	156	161	167	172	178	184	190	195	201	208	215	222	229	236
Dufferin	76	83	88	92	101	105	108	109	110	113	115	117	119	121	123	126	128
Duplex	96	98	103	106	109	114	118	123	125	129	133	137	139	144	148	152	156
Esplanade	102	105	112	115	118	121	124	127	130	133	137	140	144	147	151	155	158
Gerrard	48	50	50	47	47	47	48	49	50	51	52	52	55	56	57	59	61
Glengrove	45	46	44	45	46	44	46	46	47	49	49	52	53	55	56	57	59
John	251	271	282	293	305	314	323	332	342	352	362	373	384	395	407	419	432
Main	52	53	52	55	56	57	58	59	60	62	63	64	65	67	67	68	70
Strachan	94	96	99	102	106	108	111	114	116	119	122	125	128	132	134	137	141
Terauley	174	181	187	197	206	225	233	240	247	254	261	268	276	284	292	300	309
Wiltshire	104	104	103	98	98	98	99	101	103	105	107	109	111	113	115	117	120
Total	1555	1614	1667	1717	1773	1825	1874	1923	1967	2020	2072	2124	2178	2235	2291	2350	2412

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APPENDIX I-2

TRANSFORMER STATION WINTER PEAK LOAD FORECASTS (MVA)

COINCIDENT WITH TORONTO HYDRO SYSTEM PEAK

Station	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01
Basin	54	59	64	66	72	74	77	79	81	84	86	89	91	94	96	99	102	105
Bridgman	134	138	147	152	158	163	167	171	177	182	186	192	195	200	205	210	215	220
Carlaw	64	67	71	73	72	74	76	78	80	82	84	85	87	89	90	92	94	96
Cecil	102	107	109	110	112	115	115	118	122	126	129	133	136	140	145	148	153	157
Charles	139	141	147	158	164	171	176	182	188	194	199	205	212	219	227	234	242	250
Dufferin	89	100	109	123	130	136	142	146	151	155	159	162	165	169	172	175	179	182
Duplex	97	100	108	111	115	122	128	133	137	142	146	151	155	159	164	169	173	178
Esplanade	83	87	94	97	101	103	106	108	111	114	117	120	123	126	129	132	135	139
Gerrard	67	68	71	69	70	71	75	77	80	83	86	89	90	92	94	97	99	102
Glengrove	62	64	62	65	69	68	70	74	78	82	85	87	90	92	95	97	100	103
John	180	194	210	219	227	235	242	248	255	262	269	276	284	292	300	308	316	326
Main	67	70	72	76	80	84	88	91	95	99	104	106	108	111	114	117	120	123
Strachan	102	104	107	111	116	121	123	127	130	134	138	141	144	147	150	154	157	160
Terauley	146	152	155	163	170	181	194	201	207	213	219	225	232	238	245	251	259	266
Wiltshire	124	125	127	122	125	127	131	137	142	148	153	156	158	161	164	168	171	174
Total	1510	1576	1653	1715	1781	1845	1910	1970	2034	2100	2160	2217	2270	2329	2390	2451	2515	2581

APPENDIX J

MEMBERS OF THE JOINT ELECTRICAL ENERGY PLANNING COMMITTEE

TORONTO HYDRO

Bern Brenner - Manager, Distribution Planning and Design Department (May 1982 - June 1984)

John Brooks - Assistant Manager, Distribution Planning and Design Department

Rob Lister - Engineer, Distribution Planning and Design Department

Al Macpherson - Manager, Distribution Planning and Design Department (July - October 1984)

ONTARIO HYDRO

Ted Mackay - Manager, Regional Supply Planning, System Planning Division

Paul Vyrostko - Manager of Marketing, Central Region

John Boyd - Planning Engineer, Regional Supply Projects

CITY OF TORONTO PLANNING & DEVELOPMENT DEPARTMENT

Simon Chamberlain - Program Manager: Research & Information

Tom Ostler - Research Planner

Barbara Leonhardt - Area Planner, West-Central

CITY OF TORONTO PUBLIC WORKS DEPARTMENT

Don Batty - Supervisor, Environmental Engineering

Norm Rubin of Energy Probe attended and participated in almost all meetings of the Committee.